

# Design Manual

---

## Pre-assembled unit (LINK)

Heating and Cooling/Heating modular groups

Platform PRO



**Revision: A**

**Code: D-MNL033**

This manual has been drawn up and printed by Robur S.p.A.; whole or partial reproduction of this manual is prohibited.

The original is filed at Robur S.p.A.

Any use of this manual other than for personal consultation must be previously authorised by Robur S.p.A.

The rights of those who have legitimately filed the registered trademarks contained within this publication are not affected.

With the aim of continuously improving the quality of its products, Robur S.p.A. reserves the right to modify the data and contents of this manual without prior notice.

# INDEX OF CONTENTS

<b>1</b>	<b>OVERVIEW AND TECHNICAL CHARACTERISTICS .....</b>	<b>5</b>
1.1	TECHNICAL DATA RTAR .....	19
1.2	TECHNICAL DATA RTCF .....	22
1.3	TECHNICAL DATA RTY .....	30
1.4	TECHNICAL DATA RTRH .....	35
1.5	TECHNICAL DATA RTAH .....	38
1.6	TECHNICAL DATA RTRC .....	41
1.7	TECHNICAL DATA RTCR .....	45
1.8	TECHNICAL DATA RTYR .....	52
1.9	TECHNICAL DATA RTYH .....	63
1.10	TECHNICAL DATA RTHF .....	66
1.11	TECHNICAL DATA RTYF .....	69
1.12	TECHNICAL DATA RTAY .....	72
1.13	PRESSURE DROPS.....	76
1.14	COMBUSTION PRODUCTS .....	79
<b>2</b>	<b>SIZING AND CHECKING GAHP-A SYSTEMS .....</b>	<b>81</b>
2.1	DESIGN PARAMETERS .....	81
2.2	DESIGN PARAMETERS TABLE FOR THE INDIVIDUAL UNITS COMPOSING THE LINK.....	81
<b>3</b>	<b>PLANT DESIGN .....</b>	<b>99</b>
3.1	GENERAL DESIGN CRITERIA.....	99
3.2	INSTALLATION CRITERIA .....	104
3.3	POSITIONING THE PRE-ASSEMBLED UNIT .....	105
3.4	HYDRAULIC PLANT COMPONENTS.....	107
<b>4</b>	<b>ELECTRICAL DESIGN.....</b>	<b>109</b>
4.1	CONNECTIONS TO THE PRE-ASSEMBLED UNITS .....	109
4.2	CONNECTING THE CONTROLLER.....	109
<b>5</b>	<b>REGULATOR SYSTEM .....</b>	<b>111</b>
5.1	DIRECT DIGITAL CONTROLLER (DDC) .....	111
5.2	CONTROL AND REGULATION OF THE SYSTEM .....	112
5.3	"DEFROSTING" .....	113
5.4	"SLIDING TEMPERATURE" .....	113
5.5	CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION .....	113
5.6	REMOTE CONTROL - "WISE" (Web Invisible Service Employee).....	114
5.7	MOD BUS.....	114
<b>6</b>	<b>PLANT SCHEMATICS .....</b>	<b>117</b>
6.1	RTAR CONDITIONING PLANT - shared circulator .....	117
6.2	RTCF CONDITIONING PLANT - independent circulators .....	119
6.3	RTY UNIT HEATING AND DHW PRODUCTION SYSTEM - shared circulator.....	121
6.4	RTY UNIT HEATING AND DHW PRODUCTION SYSTEM - independent circulators .....	123
6.5	RTRH UNIT CONDITIONING AND DHW PRODUCTION SYSTEM WITH SUMMER RECOVERY CIRCUIT .....	125
6.6	RTRH UNIT CONDITIONING AND DHW PRODUCTION SYSTEM WITH SUMMER RECOVERY CIRCUIT with electronic controller.....	127
6.7	RTAH UNIT CONDITIONING AND SWIMMING POOL HEATING SYSTEM WITH SUMMER RECOVERY CIRCUIT with electronic controller.....	129
6.8	RTRC UNIT CONDITIONING AND DHW PRODUCTION SYSTEM .....	131
6.9	RTRC UNIT CONDITIONING SYSTEM with electronic controller .....	133
6.10	RTYR UNIT CONDITIONING AND DHW PRODUCTION SYSTEM .....	135
6.11	RTYH UNIT CONDITIONING AND DHW PRODUCTION SYSTEM WITH SUMMER RECOVERY CIRCUIT with electronic controller.....	137
6.12	CONDITIONING SYSTEM FOR AIR HANDLER SERVICE RTYH UNIT .....	139
6.13	RTHF UNIT CONDITIONING AND DHW PRODUCTION SYSTEM WITH SUMMER RECOVERY CIRCUIT.....	141
6.14	RTYF UNIT CONDITIONING SYSTEM with electronic controller.....	143
6.15	RTAY UNIT HEATING AND DHW PRODUCTION SYSTEM with electronic system control .....	145



## 2 SIZING AND CHECKING GAHP-A SYSTEMS

### 2.1 DESIGN PARAMETERS

The principal design parameters are the G.U.E. (Gas Utilization Efficiency) for the summer and winter and the heating and cooling powers, measured at each unit composing the heat pump unit at design conditions.

G.U.E. is the ratio between the useful heating power and the actual thermal capacity.

The G.U.E. in the winter of the GAHP-AR and GAHP-A absorption heat pumps is a direct function of the temperature of the water at the condenser inlet  $T_{hr}$  (plant return temperature) and the external air temperature  $T_a$ . The G.U.E. in the summer of the GAHP-AR and GAHP-A absorption heat pumps and the ACF chiller is a direct function of the temperature of the water at the evaporator inlet  $T_{cr}$  (plant return temperature) and the external air temperature  $T_a$ .

Obviously, the heating and cooling powers delivered by the units,  $q_h$  and  $q_c$ , are also functions of the temperatures  $T_{hr}$ ,  $T_{cr}$  and  $T_a$ , which, together with the thermal differential  $\Delta T$  of the vector fluid are assumed as design parameters. The nominal thermal differential of the vector fluid is set to 10°C in the winter and 5°C in the summer. In heating mode, the minimum and maximum thermal differentials are equal respectively to 6°C (corresponding to a maximum flow rate of 5000 l/h at the nominal thermal power) and 22°C (corresponding to a minimum flow rate of 1400 l/h at the nominal thermal power). In conditioning mode, the minimum and maximum thermal differentials are equal respectively to 4,5°C (corresponding to a maximum flow rate of 3200 l/h at the nominal thermal power) and 10°C (corresponding to a minimum flow rate of 1500 l/h at the nominal thermal power).

Given the value of  $\Delta T$  the values of  $T_{hr}$  and  $T_{cr}$  are given automatically by the desired temperature of the water in delivery to the plant,  $T_{hm}$  and  $T_{cm}$ . Once these values have been determined, simply use the heating and cooling efficiency tables in paragraph 2.2. These tables give, for each condenser return temperature  $T_{hr}$  and  $T_{cr}$ , the value of the heating power  $q_h$  and cooling power  $q_c$  of the absorption units as a function of the external air temperature  $T_a$ .

Another parameter which should be borne in mind is the maximum condenser return temperature " $T_{hr\ max}$ ", set to the value of 50°C (55°C for GAHP-A HT versions).

### 2.2 DESIGN PARAMETERS TABLE FOR THE INDIVIDUAL UNITS COMPOSING THE LINK

**Table 2.1** – Unitary heating power GAHP-AR

UNITARY HEATING POWER GAHP-AR							
EXTERNAL AIR TEMPERATURE ( $T_a$ )	WATER DELIVERY TEMPERATURE ( $T_{hm}$ )						
	30°C	35°C	40°C	45°C	50°C	55°C	60°C
	WATER RETURN TEMPERATURE ( $T_{hr}$ )						
	20°C	25°C	30°C	35°C	40°C	45°C	50°C
	$q_h$ [kW]	$q_h$ [kW]	$q_h$ [kW]	$q_h$ [kW]	$q_h$ [kW]	$q_h$ [kW]	$q_h$ [kW]
-20°C	27,30	26,50	25,70	24,90	24,90	24,60	24,30
-19°C	27,54	26,75	25,95	25,16	25,08	24,77	24,46
-18°C	27,78	26,99	26,21	25,42	25,26	24,94	24,62
-17°C	28,02	27,24	26,46	25,68	25,44	25,11	24,78
-16°C	28,26	27,49	26,71	25,94	25,62	25,28	24,94
-15°C	28,50	27,73	26,97	26,20	25,80	25,45	25,10
-14°C	28,98	28,15	27,33	26,50	26,04	25,70	25,36
-13°C	29,46	28,57	27,69	26,80	26,28	25,95	25,62
-12°C	29,94	28,99	28,05	27,10	26,52	26,20	25,88
-11°C	30,42	29,41	28,41	27,40	26,76	26,45	26,14
-10°C	30,90	29,93	28,77	27,70	27,00	26,70	26,40
-9°C	31,53	30,44	29,36	28,27	27,47	27,20	26,93

-8°C	32,17	31,06	29,94	28,83	27,93	27,70	27,47
-7°C	32,80	31,67	30,53	29,40	28,40	28,20	28,00
-6°C	33,19	32,13	31,06	30,00	28,82	28,52	28,22
-5°C	33,58	32,59	31,59	30,60	29,24	28,84	28,44
-4°C	33,97	33,04	32,12	31,20	29,67	29,17	28,67
-3°C	34,36	33,50	32,65	31,80	30,09	29,49	28,89
-2°C	34,74	33,96	33,18	32,40	30,51	29,81	29,11
-1°C	35,13	34,42	33,71	33,00	30,93	30,13	29,33
0°C	35,52	34,88	34,24	33,60	31,36	30,46	29,56
+1°C	35,91	35,34	34,77	34,20	31,78	30,78	29,78
+2°C	36,30	35,80	35,30	34,80	32,20	31,10	30,00
+3°C	36,62	36,19	35,77	35,34	32,82	31,71	30,60
+4°C	36,94	36,59	36,23	35,88	33,44	32,32	31,20
+5°C	37,26	36,98	36,70	36,42	34,06	32,93	31,80
+6°C	37,58	37,37	37,17	36,96	34,68	33,54	32,40
+7°C	37,90	37,77	37,63	37,50	35,30	34,15	33,00
+8°C	38,08	37,95	37,83	37,70	35,59	34,47	33,35
+9°C	38,25	38,13	38,02	37,90	35,88	34,79	33,70
+10°C	38,60	38,53	38,47	38,40	36,40	35,45	34,50
+11°C	38,74	38,67	38,61	38,54	36,64	35,70	34,76
+12°C	38,88	38,81	38,75	38,68	36,88	35,95	35,02
+13°C	39,02	38,95	38,89	38,82	37,12	36,20	35,28
+14°C	39,16	39,09	39,03	38,96	37,36	36,45	35,54
+15°C	39,30	39,23	39,17	39,10	37,60	36,70	35,80

**Table 2.2 – GUE GAHP-AR unit in heating mode**

GUE GAHP-AR IN HEATING MODE							
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T <sub>dm</sub> )						
	30°C	35°C	40°C	45°C	50°C	55°C	60°C
	WATER RETURN TEMPERATURE (T <sub>dr</sub> )						
	20°C	25°C	30°C	35°C	40°C	45°C	50°C
-20°C	1,083	1,052	1,020	0,988	0,988	0,976	0,964
-19°C	1,093	1,062	1,030	0,998	0,995	0,983	0,971
-18°C	1,102	1,071	1,040	1,009	1,002	0,990	0,977
-17°C	1,112	1,081	1,050	1,019	1,010	0,996	0,983
-16°C	1,121	1,091	1,060	1,029	1,017	1,003	0,990
-15°C	1,131	1,100	1,070	1,040	1,024	1,010	0,996
-14°C	1,150	1,117	1,085	1,052	1,033	1,020	1,006
-13°C	1,169	1,134	1,099	1,063	1,043	1,030	1,017
-12°C	1,188	1,150	1,113	1,075	1,052	1,040	1,027
-11°C	1,207	1,167	1,127	1,087	1,062	1,050	1,037
-10°C	1,226	1,184	1,142	1,099	1,071	1,060	1,048
-9°C	1,251	1,208	1,165	1,122	1,090	1,079	1,069
-8°C	1,277	1,233	1,188	1,144	1,108	1,099	1,090
-7°C	1,302	1,257	1,212	1,167	1,127	1,119	1,111
-6°C	1,317	1,275	1,233	1,190	1,144	1,132	1,120
-5°C	1,333	1,293	1,254	1,214	1,160	1,144	1,129
-4°C	1,348	1,311	1,275	1,238	1,177	1,158	1,138
-3°C	1,363	1,329	1,296	1,262	1,194	1,170	1,146
-2°C	1,379	1,348	1,317	1,286	1,211	1,183	1,155
-1°C	1,394	1,366	1,338	1,310	1,227	1,196	1,164
0°C	1,410	1,384	1,359	1,333	1,244	1,209	1,173
+1°C	1,425	1,402	1,380	1,357	1,261	1,221	1,182
+2°C	1,440	1,421	1,401	1,381	1,278	1,234	1,190
+3°C	1,453	1,436	1,419	1,402	1,302	1,258	1,214
+4°C	1,466	1,452	1,438	1,424	1,327	1,283	1,238
+5°C	1,479	1,467	1,456	1,445	1,352	1,307	1,262
+6°C	1,491	1,483	1,475	1,467	1,376	1,331	1,286
+7°C	1,504	1,499	1,493	1,488	1,401	1,355	1,310
+8°C	1,511	1,506	1,501	1,496	1,412	1,368	1,323
+9°C	1,518	1,513	1,509	1,504	1,424	1,381	1,337
+10°C	1,532	1,529	1,527	1,524	1,444	1,407	1,369

+11°C	1,537	1,535	1,532	1,529	1,454	1,417	1,379
+12°C	1,543	1,540	1,538	1,535	1,463	1,427	1,390
+13°C	1,548	1,546	1,543	1,540	1,473	1,437	1,400
+14°C	1,554	1,551	1,549	1,546	1,483	1,446	1,410
+15°C	1,560	1,557	1,554	1,552	1,492	1,456	1,421

**Table 2.3 – Unitary heating power GAHP-A version LT**

UNITARY HEATING POWER GAHP-A version LT						
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>dm</sub> )					
	35°C		40°C		45°C	
	50°C		55°C			
	WATER RETURN TEMPERATURE (T <sub>hr</sub> )					
	25°C		30°C		35°C	
	40°C		45°C		50°C	
	q <sub>h</sub> [kW]		q <sub>h</sub> [kW]		q <sub>h</sub> [kW]	
-20°C	30,3	28,2	26,1	24,1	21,2	
-19°C	30,5	28,5	26,4	24,3	21,4	
-18°C	30,8	28,7	26,6	24,6	21,7	
-17°C	31,0	29,0	26,9	24,8	21,9	
-16°C	31,3	29,2	27,1	25,1	22,2	
-15°C	31,5	29,5	27,4	25,3	22,4	
-14°C	32,0	30,0	27,9	25,8	22,9	
-13°C	32,5	30,5	28,4	26,3	23,4	
-12°C	33,0	31,0	28,9	26,8	23,9	
-11°C	33,5	31,5	29,4	27,3	24,4	
-10°C	34,0	32,0	29,9	27,8	24,9	
-9°C	34,9	32,8	30,8	28,7	25,8	
-8°C	35,7	33,7	31,6	29,5	26,6	
-7°C	36,6	34,5	32,4	30,4	27,5	
-6°C	37,1	35,2	33,0	30,8	28,1	
-5°C	37,7	35,9	33,6	31,3	28,7	
-4°C	38,2	36,7	34,2	31,8	29,3	
-3°C	38,8	37,4	34,8	32,3	29,9	
-2°C	39,3	38,1	35,4	32,8	30,5	
-1°C	39,5	38,5	35,9	33,4	31,0	
0°C	39,7	38,9	36,4	34,0	31,6	
+1°C	39,9	39,3	36,9	34,6	32,1	
+2°C	40,1	39,7	37,5	35,3	32,6	
+3°C	39,8	39,3	37,2	35,2	32,6	
+4°C	39,4	39,0	37,0	35,1	32,6	
+5°C	39,1	38,7	36,8	35,1	32,6	
+6°C	38,7	38,4	36,5	35,0	32,6	
+7°C	38,4	38,0	36,3	34,9	32,6	
+8°C	38,4	38,1	36,6	35,3	33,1	
+9°C	38,5	38,2	36,8	35,7	33,5	
+10°C	38,6	38,3	37,1	36,1	33,9	
+11°C	38,6	38,3	37,3	36,5	34,4	
+12°C	38,7	38,4	37,6	36,8	34,8	
+13°C	38,8	38,5	37,8	37,2	35,2	
+14°C	38,8	38,6	38,1	37,6	35,7	
+15°C	38,9	38,6	38,3	38,0	36,1	

**Table 2.4 – GUE GAHP-A unit version LT**

GUE GAHP-A version LT						
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>dm</sub> )					
	35°C		40°C		45°C	
	50°C		55°C			
	WATER RETURN TEMPERATURE (T <sub>hr</sub> )					
	25°C		30°C		35°C	
	40°C		45°C		50°C	
-20°C	1,201	1,119	1,037	0,955	0,840	
-19°C	1,211	1,129	1,047	0,965	0,850	
-18°C	1,221	1,139	1,057	0,975	0,860	
-17°C	1,231	1,149	1,067	0,985	0,870	
-16°C	1,241	1,159	1,077	0,995	0,880	
-15°C	1,251	1,169	1,087	1,005	0,890	
-14°C	1,271	1,189	1,107	1,025	0,910	
-13°C	1,291	1,209	1,127	1,045	0,930	
-12°C	1,311	1,229	1,147	1,065	0,950	

-11°C	1,331	1,249	1,167	1,085	0,970
-10°C	1,351	1,269	1,187	1,105	0,990
-9°C	1,385	1,303	1,220	1,138	1,023
-8°C	1,418	1,336	1,254	1,172	1,057
-7°C	1,452	1,369	1,287	1,205	1,090
-6°C	1,473	1,398	1,311	1,224	1,114
-5°C	1,495	1,426	1,335	1,243	1,138
-4°C	1,516	1,454	1,358	1,262	1,162
-3°C	1,538	1,483	1,382	1,281	1,186
-2°C	1,559	1,511	1,406	1,300	1,210
-1°C	1,579	1,538	1,436	1,334	1,241
0°C	1,599	1,564	1,467	1,369	1,272
+1°C	1,620	1,591	1,498	1,404	1,303
+2°C	1,641	1,619	1,529	1,440	1,335
+3°C	1,643	1,621	1,537	1,453	1,348
+4°C	1,645	1,623	1,545	1,467	1,360
+5°C	1,648	1,625	1,553	1,481	1,373
+6°C	1,650	1,627	1,561	1,495	1,386
+7°C	1,653	1,629	1,570	1,510	1,400
+8°C	1,655	1,633	1,579	1,525	1,419
+9°C	1,657	1,637	1,588	1,540	1,438
+10°C	1,659	1,640	1,598	1,555	1,456
+11°C	1,661	1,644	1,607	1,570	1,475
+12°C	1,664	1,648	1,616	1,585	1,494
+13°C	1,666	1,651	1,626	1,600	1,513
+14°C	1,668	1,655	1,635	1,615	1,531
+15°C	1,670	1,658	1,644	1,630	1,550

**Table 2.5 – Unitary heating power GAHP-A version HT**

UNITARY HEATING POWER GAHP-A version HT						
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>dm</sub> )					
	40°C	45°C	50°C	55°C	60°C	65°C
	WATER RETURN TEMPERATURE (T <sub>dr</sub> )					
	30°C	35°C	40°C	45°C	50°C	55°C
	q <sub>h</sub> [kW]	q <sub>h</sub> [kW]	q <sub>h</sub> [kW]	q <sub>h</sub> [kW]	q <sub>h</sub> [kW]	q <sub>h</sub> [kW]
-20°C	31,5	29,6	27,7	25,7	23,7	22,7
-19°C	31,8	29,9	28,0	26,0	23,9	22,9
-18°C	32,0	30,1	28,2	26,2	24,2	23,2
-17°C	32,3	30,4	28,5	26,5	24,4	23,4
-16°C	32,5	30,6	28,7	26,7	24,7	23,7
-15°C	32,8	30,9	29,0	27,0	24,9	23,9
-14°C	33,0	31,1	29,2	27,2	25,2	24,2
-13°C	33,3	31,4	29,5	27,5	25,5	24,4
-12°C	33,5	31,6	29,7	27,7	25,7	24,7
-11°C	33,8	31,9	30,0	28,0	26,0	24,9
-10°C	34,0	32,1	30,2	28,2	26,2	25,2
-9°C	35,0	32,9	30,8	28,7	26,6	25,4
-8°C	36,0	33,7	31,4	29,2	27,0	25,5
-7°C	37,0	34,5	32,0	29,7	27,5	25,7
-6°C	37,4	34,9	32,4	30,2	28,0	26,1
-5°C	37,7	35,2	32,7	30,6	28,5	26,4
-4°C	38,1	35,6	33,1	31,0	29,0	26,8
-3°C	38,5	35,9	33,4	31,4	29,5	27,1
-2°C	38,8	36,3	33,8	31,9	30,0	27,5
-1°C	38,7	36,4	34,2	32,0	29,9	27,6
0°C	38,6	36,6	34,6	32,2	29,8	27,8
+1°C	38,5	36,8	35,0	32,3	29,6	27,9
+2°C	38,4	36,9	35,4	32,5	29,5	28,1
+3°C	38,3	36,9	35,4	32,6	29,8	28,2
+4°C	38,3	36,9	35,4	32,7	30,0	28,3
+5°C	38,3	36,9	35,4	32,8	30,2	28,4
+6°C	38,2	36,8	35,4	32,9	30,5	28,5
+7°C	38,2	36,8	35,4	33,1	30,7	28,5
+8°C	38,2	36,9	35,6	33,3	31,1	29,0
+9°C	38,2	37,0	35,8	33,6	31,5	29,4
+10°C	38,1	37,0	35,9	33,9	31,9	29,8

+11°C	38,1	37,1	36,1	34,2	32,3	30,2
+12°C	38,1	37,2	36,2	34,5	32,7	30,6
+13°C	38,0	37,2	36,4	34,8	33,1	31,0
+14°C	38,0	37,3	36,6	35,1	33,5	31,4
+15°C	38,0	37,3	36,7	35,3	34,0	31,8

**Table 2.6 – GUE GAHP-A unit version HT**

GUE GAHP-A version HT						
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T <sub>dm</sub> )					
	40°C	45°C	50°C	55°C	60°C	65°C
	WATER RETURN TEMPERATURE (T <sub>dr</sub> )					
	30°C	35°C	40°C	45°C	50°C	55°C
-20°C	1,250	1,175	1,100	1,020	0,940	0,900
-19°C	1,260	1,185	1,110	1,030	0,950	0,910
-18°C	1,270	1,195	1,120	1,040	0,960	0,920
-17°C	1,280	1,205	1,130	1,050	0,970	0,930
-16°C	1,290	1,215	1,140	1,060	0,980	0,940
-15°C	1,300	1,225	1,150	1,070	0,990	0,950
-14°C	1,310	1,235	1,160	1,080	1,000	0,960
-13°C	1,320	1,245	1,170	1,090	1,010	0,970
-12°C	1,330	1,255	1,180	1,100	1,020	0,980
-11°C	1,340	1,265	1,190	1,110	1,030	0,990
-10°C	1,350	1,275	1,200	1,120	1,040	1,000
-9°C	1,390	1,307	1,223	1,140	1,057	1,007
-8°C	1,430	1,338	1,247	1,160	1,073	1,013
-7°C	1,470	1,370	1,270	1,180	1,090	1,020
-6°C	1,484	1,384	1,284	1,197	1,110	1,034
-5°C	1,498	1,398	1,298	1,214	1,130	1,048
-4°C	1,512	1,412	1,312	1,231	1,150	1,062
-3°C	1,526	1,426	1,326	1,248	1,170	1,076
-2°C	1,540	1,440	1,340	1,265	1,190	1,090
-1°C	1,547	1,457	1,366	1,281	1,195	1,105
0°C	1,555	1,474	1,393	1,297	1,201	1,120
+1°C	1,562	1,491	1,420	1,314	1,206	1,135
+2°C	1,570	1,509	1,448	1,330	1,212	1,150
+3°C	1,575	1,519	1,462	1,347	1,231	1,166
+4°C	1,581	1,528	1,476	1,363	1,251	1,183
+5°C	1,586	1,538	1,490	1,380	1,270	1,200
+6°C	1,591	1,548	1,504	1,397	1,291	1,218
+7°C	1,597	1,558	1,519	1,415	1,311	1,236
+8°C	1,602	1,565	1,527	1,428	1,329	1,254
+9°C	1,607	1,571	1,534	1,441	1,348	1,272
+10°C	1,613	1,578	1,542	1,454	1,367	1,290
+11°C	1,618	1,584	1,549	1,467	1,385	1,308
+12°C	1,624	1,590	1,557	1,480	1,404	1,326
+13°C	1,629	1,597	1,565	1,494	1,423	1,344
+14°C	1,634	1,603	1,572	1,507	1,441	1,362
+15°C	1,640	1,610	1,580	1,520	1,460	1,380

**Table 2.7 – AY00-120 CONDENSING UNIT EFFICIENCY**

WATER RETURN TEMPERATURE (Thr)	GUE AY Condensing unit
20	1,05
25	1,05
30	1,04
35	1,03
40	1,02
45	1,01
50	0,99
55	0,98
60	0,97
65	0,93
70	0,93

**Table 2.8 – Unitary cooling power GAHP-AR**

UNITARY COOLING POWER GAHP-AR								
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
15°C	19,00	18,93	18,85	18,78	18,70	18,75	18,80	18,85
16°C	18,92	18,86	18,80	18,74	18,68	18,73	18,79	18,84
17°C	18,84	18,80	18,75	18,71	18,66	18,72	18,77	18,83
18°C	18,76	18,73	18,70	18,67	18,64	18,70	18,76	18,82
19°C	18,68	18,67	18,65	18,64	18,62	18,68	18,75	18,81
20°C	18,60	18,60	18,60	18,60	18,60	18,67	18,73	18,80
21°C	18,40	18,44	18,47	18,51	18,54	18,61	18,68	18,75
22°C	18,20	18,27	18,34	18,41	18,48	18,55	18,63	18,70
23°C	18,00	18,11	18,21	18,32	18,42	18,50	18,57	18,65
24°C	17,80	17,94	18,08	18,22	18,36	18,44	18,52	18,60
25°C	17,60	17,78	17,95	18,13	18,30	18,38	18,47	18,55
26°C	17,26	17,50	17,73	17,97	18,20	18,29	18,37	18,46
27°C	16,92	17,22	17,51	17,81	18,10	18,19	18,28	18,37
28°C	16,58	16,94	17,29	17,65	18,00	18,09	18,19	18,28
29°C	16,24	16,66	17,07	17,49	17,90	18,00	18,09	18,19
30°C	15,90	16,38	16,85	17,33	17,80	17,90	18,00	18,10
31°C	15,30	15,88	16,46	17,04	17,62	17,73	17,85	17,96
32°C	14,70	15,39	16,07	16,76	17,44	17,57	17,69	17,82
33°C	14,10	14,89	15,68	16,47	17,26	17,40	17,54	17,68
34°C	13,50	14,40	15,29	16,19	17,08	17,23	17,39	17,54
35°C	12,90	13,90	14,90	15,90	16,90	17,07	17,23	17,40
36°C	\	\	\	\	16,52	16,72	16,92	17,12
37°C	\	\	\	\	16,14	16,37	16,61	16,84
38°C	\	\	\	\	15,76	16,03	16,29	16,56
39°C	\	\	\	\	15,38	15,68	15,98	16,28
40°C	\	\	\	\	15,00	15,33	15,67	16,00
41°C	\	\	\	\	\	\	\	15,50
42°C	\	\	\	\	\	\	\	15,00
43°C	\	\	\	\	\	\	\	14,50
44°C	\	\	\	\	\	\	\	14,00
45°C	\	\	\	\	\	\	\	13,50

**Table 2.9 – GUE GAHP-AR unit in conditioning mode**

GUE GAHP-AR IN CONDITIONING MODE								
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
15°C	0,754	0,751	0,748	0,745	0,742	0,744	0,746	0,748
16°C	0,751	0,748	0,746	0,744	0,741	0,743	0,746	0,748
17°C	0,748	0,746	0,744	0,742	0,740	0,743	0,745	0,747
18°C	0,744	0,743	0,742	0,741	0,740	0,742	0,744	0,747
19°C	0,741	0,741	0,740	0,740	0,739	0,741	0,744	0,746
20°C	0,738	0,738	0,738	0,738	0,738	0,741	0,743	0,746
21°C	0,730	0,732	0,733	0,735	0,736	0,738	0,741	0,744
22°C	0,722	0,725	0,728	0,731	0,733	0,736	0,739	0,742
23°C	0,714	0,719	0,723	0,727	0,731	0,734	0,737	0,740
24°C	0,706	0,712	0,717	0,723	0,729	0,732	0,735	0,738
25°C	0,698	0,706	0,712	0,719	0,726	0,729	0,733	0,736
26°C	0,685	0,694	0,704	0,713	0,722	0,726	0,729	0,733
27°C	0,671	0,683	0,695	0,707	0,718	0,722	0,725	0,729
28°C	0,658	0,672	0,686	0,700	0,714	0,718	0,722	0,725
29°C	0,644	0,661	0,677	0,694	0,710	0,714	0,718	0,722
30°C	0,631	0,650	0,669	0,688	0,706	0,710	0,714	0,718
31°C	0,607	0,630	0,653	0,676	0,699	0,704	0,708	0,713
32°C	0,583	0,611	0,638	0,665	0,692	0,697	0,702	0,707
33°C	0,560	0,591	0,622	0,654	0,685	0,690	0,696	0,702
34°C	0,536	0,571	0,607	0,642	0,678	0,684	0,690	0,696

35°C	0,512	0,552	0,591	0,631	0,671	0,677	0,684	0,690
36°C	\	\	\	\	0,656	0,663	0,671	0,679
37°C	\	\	\	\	0,640	0,650	0,659	0,668
38°C	\	\	\	\	0,625	0,636	0,646	0,657
39°C	\	\	\	\	0,610	0,622	0,634	0,646
40°C	\	\	\	\	0,595	0,608	0,622	0,635
41°C	\	\	\	\	\	\	\	0,615
42°C	\	\	\	\	\	\	\	0,595
43°C	\	\	\	\	\	\	\	0,575
44°C	\	\	\	\	\	\	\	0,556
45°C	\	\	\	\	\	\	\	0,536

**Table 2.10** – Unitary cooling power ACF 60-00

UNITARY COOLING POWER ACF60-00								
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
0°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
1°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
2°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
3°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
4°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
5°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
6°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
7°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
8°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
9°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
10°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
11°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
12°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
13°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
14°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
15°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
16°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
17°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
18°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
19°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
20°C	17,37	17,45	17,54	17,72	17,90	18,07	18,25	18,37
21°C	17,33	17,44	17,54	17,72	17,90	18,07	18,25	18,37
22°C	17,29	17,42	17,54	17,72	17,90	18,07	18,25	18,37
23°C	17,26	17,40	17,54	17,72	17,90	18,07	18,25	18,37
24°C	17,22	17,38	17,54	17,72	17,90	18,07	18,25	18,37
25°C	17,19	17,37	17,54	17,72	17,90	18,07	18,25	18,37
26°C	16,94	17,22	17,51	17,70	17,90	18,07	18,25	18,37
27°C	16,69	17,08	17,47	17,68	17,90	18,07	18,25	18,37
28°C	16,44	16,94	17,44	17,67	17,90	18,07	18,25	18,37
29°C	16,20	16,80	17,40	17,65	17,90	18,07	18,25	18,37
30°C	15,95	16,66	17,37	17,63	17,90	18,07	18,25	18,37
31°C	15,13	16,05	16,98	17,42	17,86	18,04	18,22	18,13
32°C	14,32	15,45	16,59	17,21	17,83	18,00	18,18	17,89
33°C	13,50	14,85	16,20	16,99	17,79	17,97	18,15	17,65
34°C	12,69	14,25	15,81	16,78	17,76	17,93	18,11	17,41
35°C	11,87	13,64	15,42	16,57	17,72	17,90	18,07	17,18
36°C	\	\	\	\	17,29	17,53	17,76	16,94
37°C	\	\	\	\	16,87	17,15	17,44	16,70
38°C	\	\	\	\	16,44	16,78	17,12	16,46
39°C	\	\	\	\	16,02	16,41	16,80	16,22
40°C	\	\	\	\	15,59	16,04	16,48	15,99
41°C	\	\	\	\	14,85	15,40	15,95	15,75
42°C	\	\	\	\	14,11	14,76	15,42	15,51
43°C	\	\	\	\	13,36	14,12	14,88	15,27
44°C	\	\	\	\	12,62	13,48	14,35	15,03
45°C	\	\	\	\	11,87	12,85	13,82	14,80

**Table 2.11 – GUE ACF60-00 unit**

GUE ACF60-00								
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
0°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
1°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
2°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
3°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
4°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
5°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
6°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
7°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
8°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
9°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
10°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
11°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
12°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
13°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
14°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
15°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
16°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
17°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
18°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
19°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
20°C	0,695	0,698	0,702	0,709	0,716	0,723	0,730	0,735
21°C	0,693	0,698	0,702	0,709	0,716	0,723	0,730	0,735
22°C	0,692	0,697	0,702	0,709	0,716	0,723	0,730	0,735
23°C	0,690	0,696	0,702	0,709	0,716	0,723	0,730	0,735
24°C	0,689	0,695	0,702	0,709	0,716	0,723	0,730	0,735
25°C	0,688	0,695	0,702	0,709	0,716	0,723	0,730	0,735
26°C	0,678	0,689	0,700	0,708	0,716	0,723	0,730	0,735
27°C	0,668	0,683	0,699	0,707	0,716	0,723	0,730	0,735
28°C	0,658	0,678	0,698	0,707	0,716	0,723	0,730	0,735
29°C	0,648	0,672	0,696	0,706	0,716	0,723	0,730	0,735
30°C	0,638	0,666	0,695	0,705	0,716	0,723	0,730	0,735
31°C	0,605	0,642	0,679	0,697	0,714	0,722	0,729	0,725
32°C	0,573	0,618	0,664	0,688	0,713	0,720	0,727	0,716
33°C	0,540	0,594	0,648	0,680	0,712	0,719	0,726	0,706
34°C	0,508	0,570	0,632	0,671	0,710	0,717	0,724	0,696
35°C	0,475	0,546	0,617	0,663	0,709	0,716	0,723	0,687
36°C	\	\	\	\	0,692	0,701	0,710	0,678
37°C	\	\	\	\	0,675	0,686	0,698	0,668
38°C	\	\	\	\	0,658	0,671	0,685	0,658
39°C	\	\	\	\	0,641	0,656	0,672	0,649
40°C	\	\	\	\	0,624	0,642	0,659	0,640
41°C	\	\	\	\	0,594	0,616	0,638	0,630
42°C	\	\	\	\	0,564	0,590	0,617	0,620
43°C	\	\	\	\	0,534	0,565	0,595	0,611
44°C	\	\	\	\	0,505	0,539	0,574	0,601
45°C	\	\	\	\	0,475	0,514	0,553	0,592

**Table 2.12 – Unitary cooling power ACF 60-00 version TK**

UNITARY COOLING POWER ACF60-00 version TK							
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )						
	3°C	4°C	5°C	6°C	7°C	8°C	9°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )						
	8°C	9°C	10°C	11°C	12°C	13°C	14°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
-12°C	20,91	20,91	20,91	21,00	21,09	21,18	21,26
-11°C	20,91	20,91	20,91	20,95	21,00	21,09	21,18
-10°C	20,91	20,91	20,91	20,91	20,91	21,00	21,09
-9°C	20,82	20,82	20,82	20,87	20,91	21,00	21,09
-8°C	20,73	20,73	20,73	20,82	20,91	21,00	21,09
-7°C	20,64	20,64	20,64	20,73	20,82	20,91	21,00

UNITARY COOLING POWER ACF60-00 version TK							
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )						
	3°C	4°C	5°C	6°C	7°C	8°C	9°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )						
	8°C	9°C	10°C	11°C	12°C	13°C	14°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
-6°C	20,56	20,56	20,56	20,64	20,73	20,82	20,91
-5°C	20,56	20,56	20,56	20,60	20,64	20,78	20,91
-4°C	20,56	20,56	20,56	20,56	20,56	20,73	20,91
-3°C	20,47	20,47	20,47	20,51	20,56	20,69	20,82
-2°C	20,38	20,38	20,38	20,47	20,56	20,64	20,73
-1°C	20,38	20,38	20,38	20,42	20,47	20,56	20,64
0°C	20,38	20,38	20,38	20,38	20,38	20,47	20,56
1°C	20,29	20,29	20,29	20,33	20,38	20,47	20,56
2°C	20,20	20,20	20,20	20,29	20,38	20,47	20,56
3°C	20,20	20,20	20,20	20,25	20,29	20,38	20,47
4°C	20,20	20,20	20,20	20,20	20,20	20,29	20,38
5°C	20,11	20,11	20,11	20,16	20,20	20,29	20,38
6°C	20,02	20,02	20,02	20,11	20,20	20,29	20,38
7°C	19,94	19,98	20,02	20,07	20,11	20,20	20,29
8°C	19,85	19,94	20,02	20,02	20,02	20,11	20,20
9°C	19,85	19,89	19,94	19,94	19,94	20,02	20,11
10°C	19,85	19,85	19,85	19,85	19,85	19,94	20,02
11°C	19,85	19,85	19,85	19,85	19,85	19,94	20,02
12°C	19,85	19,85	19,85	19,85	19,85	19,94	20,02
13°C	19,76	19,76	19,76	19,76	19,76	19,85	19,94
14°C	19,67	19,67	19,67	19,67	19,67	19,76	19,85
15°C	19,67	19,67	19,67	19,67	19,67	19,76	19,85
16°C	19,67	19,67	19,67	19,67	19,67	19,76	19,85
17°C	19,58	19,58	19,58	19,62	19,67	19,71	19,76
18°C	19,49	19,49	19,49	19,58	19,67	19,67	19,67
19°C	19,40	19,40	19,40	19,54	19,67	19,67	19,67
20°C	19,31	19,31	19,31	19,49	19,67	19,67	19,67
21°C	19,23	19,23	19,23	19,40	19,58	19,58	19,58
22°C	19,14	19,14	19,14	19,31	19,49	19,49	19,49
23°C	18,96	18,96	18,96	19,23	19,49	19,49	19,49
24°C	18,78	18,78	18,78	19,14	19,49	19,49	19,49
25°C	18,52	18,61	18,69	19,05	19,40	19,40	19,40
26°C	18,25	18,43	18,61	18,96	19,31	19,31	19,31
27°C	17,81	18,07	18,34	18,78	19,23	19,23	19,23
28°C	17,37	17,72	18,07	18,61	19,14	19,14	19,14
29°C	16,83	17,32	17,81	18,38	18,96	19,00	19,05
30°C	16,30	16,92	17,54	18,16	18,78	18,87	18,96
31°C	15,68	16,44	17,19	17,90	18,61	18,74	18,87
32°C	15,06	15,95	16,83	17,63	18,43	18,61	18,78
33°C	14,18	15,28	16,39	17,32	18,25	18,43	18,61
34°C	13,29	14,62	15,95	17,01	18,07	18,25	18,43
35°C	12,23	13,82	15,42	16,57	17,72	17,99	18,25
36°C	\	\	\	\	17,37	17,72	18,07
37°C	\	\	\	\	17,01	17,41	17,81
38°C	\	\	\	\	16,66	17,10	17,54
39°C	\	\	\	\	16,21	16,70	17,19
40°C	\	\	\	\	15,77	16,30	16,83
41°C	\	\	\	\	15,24	15,86	16,48
42°C	\	\	\	\	14,71	15,42	16,13
43°C	\	\	\	\	\	\	15,59
44°C	\	\	\	\	\	\	15,06
45°C	\	\	\	\	\	\	14,53

Table 2.13 – GUE ACF60-00 unit version TK

GUE ACF60-00 version TK							
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )						
	3°C	4°C	5°C	6°C	7°C	8°C	9°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )						
	8°C	9°C	10°C	11°C	12°C	13°C	14°C
-12°C	0,836	0,836	0,836	0,840	0,844	0,847	0,850

GUE ACF60-00 version TK							
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )						
	3°C	4°C	5°C	6°C	7°C	8°C	9°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )						
	8°C	9°C	10°C	11°C	12°C	13°C	14°C
-11°C	0,836	0,836	0,836	0,838	0,840	0,844	0,847
-10°C	0,836	0,836	0,836	0,836	0,836	0,840	0,844
-9°C	0,833	0,833	0,833	0,835	0,836	0,840	0,844
-8°C	0,829	0,829	0,829	0,833	0,836	0,840	0,844
-7°C	0,826	0,826	0,826	0,829	0,833	0,836	0,840
-6°C	0,822	0,822	0,822	0,826	0,829	0,833	0,836
-5°C	0,822	0,822	0,822	0,824	0,826	0,831	0,836
-4°C	0,822	0,822	0,822	0,822	0,822	0,829	0,836
-3°C	0,819	0,819	0,819	0,820	0,822	0,828	0,833
-2°C	0,815	0,815	0,815	0,819	0,822	0,826	0,829
-1°C	0,815	0,815	0,815	0,817	0,819	0,822	0,826
0°C	0,815	0,815	0,815	0,815	0,815	0,819	0,822
1°C	0,812	0,812	0,812	0,813	0,815	0,819	0,822
2°C	0,808	0,808	0,808	0,812	0,815	0,819	0,822
3°C	0,808	0,808	0,808	0,810	0,812	0,815	0,819
4°C	0,808	0,808	0,808	0,808	0,808	0,812	0,815
5°C	0,804	0,804	0,804	0,806	0,808	0,812	0,815
6°C	0,801	0,801	0,801	0,804	0,808	0,812	0,815
7°C	0,798	0,799	0,801	0,803	0,804	0,808	0,812
8°C	0,794	0,798	0,801	0,801	0,801	0,804	0,808
9°C	0,794	0,796	0,798	0,798	0,798	0,801	0,804
10°C	0,794	0,794	0,794	0,794	0,794	0,798	0,801
11°C	0,794	0,794	0,794	0,794	0,794	0,798	0,801
12°C	0,794	0,794	0,794	0,794	0,794	0,798	0,801
13°C	0,790	0,790	0,790	0,790	0,790	0,794	0,798
14°C	0,787	0,787	0,787	0,787	0,787	0,790	0,794
15°C	0,787	0,787	0,787	0,787	0,787	0,790	0,794
16°C	0,787	0,787	0,787	0,787	0,787	0,790	0,794
17°C	0,783	0,783	0,783	0,785	0,787	0,788	0,790
18°C	0,780	0,780	0,780	0,783	0,787	0,787	0,787
19°C	0,776	0,776	0,776	0,782	0,787	0,787	0,787
20°C	0,772	0,772	0,772	0,780	0,787	0,787	0,787
21°C	0,769	0,769	0,769	0,776	0,783	0,783	0,783
22°C	0,766	0,766	0,766	0,772	0,780	0,780	0,780
23°C	0,758	0,758	0,758	0,769	0,780	0,780	0,780
24°C	0,751	0,751	0,751	0,766	0,780	0,780	0,780
25°C	0,741	0,744	0,748	0,762	0,776	0,776	0,776
26°C	0,730	0,737	0,744	0,758	0,772	0,772	0,772
27°C	0,712	0,723	0,734	0,751	0,769	0,769	0,769
28°C	0,695	0,709	0,723	0,744	0,766	0,766	0,766
29°C	0,673	0,693	0,712	0,735	0,758	0,760	0,762
30°C	0,652	0,677	0,702	0,726	0,751	0,755	0,758
31°C	0,627	0,658	0,688	0,716	0,744	0,750	0,755
32°C	0,602	0,638	0,673	0,705	0,737	0,744	0,751
33°C	0,567	0,611	0,656	0,693	0,730	0,737	0,744
34°C	0,532	0,585	0,638	0,680	0,723	0,730	0,737
35°C	0,489	0,553	0,617	0,663	0,709	0,720	0,730
36°C	\	\	\	\	0,695	0,709	0,723
37°C	\	\	\	\	0,680	0,696	0,712
38°C	\	\	\	\	0,666	0,684	0,702
39°C	\	\	\	\	0,648	0,668	0,688
40°C	\	\	\	\	0,631	0,652	0,673
41°C	\	\	\	\	0,610	0,634	0,659
42°C	\	\	\	\	0,588	0,617	0,645
43°C	\	\	\	\	\	\	0,624
44°C	\	\	\	\	\	\	0,602
45°C	\	\	\	\	\	\	0,581

**Table 2.14 – Unitary cooling power ACF 60-00 version HT**

UNITARY COOLING POWER ACF60-00 version HT										
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )									
	5°C	6°C	7°C	8°C	9°C	10°C	11°C	12°C	13°C	14°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )									
	10°C	11°C	12°C	13°C	14°C	15°C	16°C	17°C	18°C	19°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
0°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
1°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
2°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
3°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
4°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
5°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
6°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
7°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
8°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
9°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
10°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
11°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
12°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
13°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
14°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
15°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
16°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
17°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
18°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
19°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
20°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
21°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
22°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
23°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
24°C	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
25°C	17,38	17,42	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
26°C	17,29	17,38	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
27°C	17,29	17,38	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
28°C	17,29	17,38	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
29°C	17,29	17,38	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
30°C	17,29	17,38	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
31°C	17,12	17,29	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
32°C	16,95	17,21	17,46	17,46	17,46	17,46	17,46	17,46	17,55	17,63
33°C	16,69	17,03	17,38	17,38	17,38	17,38	17,38	17,38	17,46	17,55
34°C	16,44	16,86	17,29	17,29	17,29	17,29	17,29	17,29	17,38	17,46
35°C	16,09	16,61	17,12	17,12	17,12	17,12	17,21	17,29	17,38	17,46
36°C	15,75	16,35	16,95	17,03	17,08	17,12	17,12	17,12	17,29	17,46
37°C	15,32	16,05	16,78	16,91	16,97	17,03	17,03	17,03	17,21	17,38
38°C	14,89	15,75	16,61	16,78	16,86	16,95	16,95	16,95	17,12	17,29
39°C	14,47	15,37	16,26	16,52	16,65	16,78	16,82	16,86	17,03	17,21
40°C	14,04	14,98	15,92	16,26	16,44	16,61	16,69	16,78	16,95	17,12
41°C	\	\	15,49	15,92	16,14	16,35	16,52	16,69	16,86	17,03
42°C	\	\	15,07	15,58	15,84	16,09	16,35	16,61	16,78	16,95
43°C	\	\	14,55	15,19	15,52	15,84	16,14	16,44	16,61	16,78
44°C	\	\	14,04	14,81	15,19	15,58	15,92	16,26	16,44	16,61
45°C	\	\	\	\	\	15,15	15,58	16,01	16,22	16,44
46°C	\	\	\	\	\	14,72	15,24	15,75	16,01	16,26
47°C	\	\	\	\	\	14,21	14,77	15,32	15,62	15,92
48°C	\	\	\	\	\	13,70	14,30	14,89	15,24	15,58
49°C	\	\	\	\	\	\	\	14,38	14,77	15,15
50°C	\	\	\	\	\	\	\	13,87	14,30	14,72

**Table 2.15 – GUE ACF60-00 unit version HT**

GUE ACF60-00 version HT										
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )									
	5°C	6°C	7°C	8°C	9°C	10°C	11°C	12°C	13°C	14°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )									
	10°C	11°C	12°C	13°C	14°C	15°C	16°C	17°C	18°C	19°C
0°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705

GUE ACF60-00 version HT										
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )									
	5°C	6°C	7°C	8°C	9°C	10°C	11°C	12°C	13°C	14°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )									
	10°C	11°C	12°C	13°C	14°C	15°C	16°C	17°C	18°C	19°C
1°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
2°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
3°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
4°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
5°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
6°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
7°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
8°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
9°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
10°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
11°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
12°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
13°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
14°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
15°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
16°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
17°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
18°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
19°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
20°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
21°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
22°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
23°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
24°C	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
25°C	0,695	0,697	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
26°C	0,692	0,695	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
27°C	0,692	0,695	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
28°C	0,692	0,695	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
29°C	0,692	0,695	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
30°C	0,692	0,695	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
31°C	0,685	0,692	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
32°C	0,678	0,688	0,698	0,698	0,698	0,698	0,698	0,698	0,702	0,705
33°C	0,668	0,681	0,695	0,695	0,695	0,695	0,695	0,695	0,698	0,702
34°C	0,658	0,674	0,692	0,692	0,692	0,692	0,692	0,692	0,695	0,698
35°C	0,644	0,664	0,685	0,685	0,685	0,685	0,688	0,692	0,695	0,698
36°C	0,630	0,654	0,678	0,681	0,683	0,685	0,685	0,685	0,692	0,698
37°C	0,613	0,642	0,671	0,676	0,679	0,681	0,681	0,681	0,688	0,695
38°C	0,596	0,630	0,664	0,671	0,674	0,678	0,678	0,678	0,685	0,692
39°C	0,579	0,615	0,650	0,661	0,666	0,671	0,673	0,674	0,681	0,688
40°C	0,562	0,599	0,637	0,650	0,658	0,664	0,668	0,671	0,678	0,685
41°C	\	\	0,620	0,637	0,646	0,654	0,661	0,668	0,674	0,681
42°C	\	\	0,603	0,623	0,634	0,644	0,654	0,664	0,671	0,678
43°C	\	\	0,582	0,608	0,621	0,634	0,646	0,658	0,664	0,671
44°C	\	\	0,562	0,592	0,608	0,623	0,637	0,650	0,658	0,664
45°C	\	\	\	\	\	0,606	0,623	0,640	0,649	0,658
46°C	\	\	\	\	\	0,589	0,610	0,630	0,640	0,650
47°C	\	\	\	\	\	0,568	0,591	0,613	0,625	0,637
48°C	\	\	\	\	\	0,548	0,572	0,596	0,610	0,623
49°C	\	\	\	\	\	\	\	0,575	0,591	0,606
50°C	\	\	\	\	\	\	\	0,555	0,572	0,589

**Table 2.16 – Unitary cooling power ACF 60-00 version LB**

UNITARY COOLING POWER ACF60-00 version LB											
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )										
	-10°C	-9°C	-8°C	-7°C	-6°C	-5°C	-4°C	-3°C	-2°C	-1°C	0°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )										
	-5°C	-4°C	-3°C	-2°C	-1°C	0°C	1°C	2°C	3°C	4°C	5°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
-5°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
-4°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
-3°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56

UNITARY COOLING POWER ACF60-00 version LB											
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )										
	-10°C	-9°C	-8°C	-7°C	-6°C	-5°C	-4°C	-3°C	-2°C	-1°C	0°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )										
	-5°C	-4°C	-3°C	-2°C	-1°C	0°C	1°C	2°C	3°C	4°C	5°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
-2°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
-1°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
0°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
1°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
2°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
3°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
4°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
5°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
6°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
7°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
8°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
9°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
10°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
11°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
12°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
13°C	15,16	15,21	15,25	15,30	15,30	15,30	15,34	15,39	15,43	15,50	15,56
14°C	15,16	15,16	15,16	15,16	15,23	15,30	15,34	15,39	15,43	15,50	15,56
15°C	15,16	15,16	15,16	15,16	15,23	15,30	15,34	15,39	15,43	15,50	15,56
16°C	15,03	15,07	15,12	15,16	15,23	15,30	15,34	15,39	15,43	15,50	15,56
17°C	15,03	15,07	15,12	15,16	15,23	15,30	15,34	15,39	15,43	15,50	15,56
18°C	14,90	14,94	14,99	15,03	15,17	15,30	15,34	15,39	15,43	15,50	15,56
19°C	14,90	14,94	14,99	15,03	15,10	15,16	15,25	15,34	15,43	15,50	15,56
20°C	14,76	14,85	14,94	15,03	15,10	15,16	15,25	15,34	15,43	15,50	15,56
21°C	14,63	14,72	14,81	14,90	15,03	15,16	15,21	15,25	15,30	15,43	15,56
22°C	14,63	14,67	14,72	14,76	14,90	15,03	15,12	15,21	15,30	15,43	15,56
23°C	14,50	14,59	14,67	14,76	14,90	15,03	15,12	15,21	15,30	15,43	15,56
24°C	14,36	14,45	14,54	14,63	14,77	14,90	14,99	15,07	15,16	15,36	15,56
25°C	14,10	14,23	14,37	14,50	14,70	14,90	14,99	15,07	15,16	15,30	15,43
26°C	13,97	14,10	14,23	14,36	14,56	14,76	14,85	14,94	15,03	15,23	15,43
27°C	13,83	13,96	14,10	14,23	14,43	14,63	14,76	14,90	15,03	15,17	15,30
28°C	13,57	13,75	13,92	14,10	14,30	14,50	14,63	14,77	14,90	15,10	15,30
29°C	13,43	13,61	13,79	13,97	14,17	14,36	14,49	14,63	14,76	14,96	15,16
30°C	13,17	13,35	13,52	13,70	13,97	14,23	14,36	14,50	14,63	14,90	15,16
31°C	12,90	13,12	13,35	13,57	13,84	14,10	14,23	14,37	14,50	14,77	15,03
32°C	12,64	12,86	13,08	13,30	13,64	13,97	14,10	14,23	14,36	14,63	14,90
33°C	12,37	12,59	12,81	13,03	13,37	13,70	13,88	14,05	14,23	14,50	14,76
34°C	11,97	12,24	12,50	12,77	13,17	13,57	13,75	13,92	14,10	14,37	14,63
35°C	11,70	11,97	12,23	12,50	12,90	13,30	13,48	13,65	13,83	14,10	14,36
36°C	11,31	11,62	11,93	12,24	12,64	13,03	13,21	13,39	13,57	13,90	14,23
37°C	10,91	11,22	11,53	11,84	12,31	12,77	12,99	13,21	13,43	13,70	13,97
38°C	10,51	10,86	11,22	11,57	12,04	12,50	12,72	12,95	13,17	13,50	13,83
39°C	10,11	10,46	10,82	11,17	11,71	12,24	12,46	12,68	12,90	13,24	13,57
40°C	9,58	9,98	10,37	10,77	11,31	11,84	12,11	12,37	12,64	12,97	13,30
41°C	9,18	9,58	9,97	10,37	10,97	11,57	11,79	12,02	12,24	12,64	13,03
42°C	8,65	9,05	9,44	9,84	10,51	11,17	11,44	11,70	11,97	12,31	12,64
43°C	8,11	8,55	9,00	9,44	10,11	10,77	11,04	11,30	11,57	11,97	12,37
44°C	7,58	8,02	8,47	8,91	9,64	10,37	10,64	10,90	11,17	11,57	11,97
45°C	6,92	7,41	7,89	8,38	9,18	9,98	10,24	10,51	10,77	11,17	11,57

Table 2.17 – GUE ACF60-00 unit version LB

GUE ACF60-00 version LB											
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )										
	-10°C	-9°C	-8°C	-7°C	-6°C	-5°C	-4°C	-3°C	-2°C	-1°C	0°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )										
	-5°C	-4°C	-3°C	-2°C	-1°C	0°C	1°C	2°C	3°C	4°C	5°C
-5°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
-4°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
-3°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
-2°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
-1°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622

GUE ACF60-00 version LB											
EXTERNAL AIR TEMPERATURE ( $T_a$ )	WATER DELIVERY TEMPERATURE ( $T_{cm}$ )										
	-10°C	-9°C	-8°C	-7°C	-6°C	-5°C	-4°C	-3°C	-2°C	-1°C	0°C
	WATER RETURN TEMPERATURE ( $T_{cr}$ )										
	-5°C	-4°C	-3°C	-2°C	-1°C	0°C	1°C	2°C	3°C	4°C	5°C
0°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
1°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
2°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
3°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
4°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
5°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
6°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
7°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
8°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
9°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
10°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
11°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
12°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
13°C	0,606	0,608	0,610	0,612	0,612	0,612	0,614	0,616	0,617	0,620	0,622
14°C	0,606	0,606	0,606	0,606	0,609	0,612	0,614	0,616	0,617	0,620	0,622
15°C	0,606	0,606	0,606	0,606	0,609	0,612	0,614	0,616	0,617	0,620	0,622
16°C	0,601	0,603	0,605	0,606	0,609	0,612	0,614	0,616	0,617	0,620	0,622
17°C	0,601	0,603	0,605	0,606	0,609	0,612	0,614	0,616	0,617	0,620	0,622
18°C	0,596	0,598	0,600	0,601	0,607	0,612	0,614	0,616	0,617	0,620	0,622
19°C	0,596	0,598	0,600	0,601	0,604	0,606	0,610	0,614	0,617	0,620	0,622
20°C	0,590	0,594	0,598	0,601	0,604	0,606	0,610	0,614	0,617	0,620	0,622
21°C	0,585	0,589	0,592	0,596	0,601	0,606	0,608	0,610	0,612	0,617	0,622
22°C	0,585	0,587	0,589	0,590	0,596	0,601	0,605	0,608	0,612	0,617	0,622
23°C	0,580	0,584	0,587	0,590	0,596	0,601	0,605	0,608	0,612	0,617	0,622
24°C	0,574	0,578	0,582	0,585	0,591	0,596	0,600	0,603	0,606	0,614	0,622
25°C	0,564	0,569	0,575	0,580	0,588	0,596	0,600	0,603	0,606	0,612	0,617
26°C	0,559	0,564	0,569	0,574	0,582	0,590	0,594	0,598	0,601	0,609	0,617
27°C	0,553	0,558	0,564	0,569	0,577	0,585	0,590	0,596	0,601	0,607	0,612
28°C	0,543	0,550	0,557	0,564	0,572	0,580	0,585	0,591	0,596	0,604	0,612
29°C	0,537	0,544	0,552	0,559	0,567	0,574	0,580	0,585	0,590	0,598	0,606
30°C	0,527	0,534	0,541	0,548	0,559	0,569	0,574	0,580	0,585	0,596	0,606
31°C	0,516	0,525	0,534	0,543	0,554	0,564	0,569	0,575	0,580	0,591	0,601
32°C	0,506	0,514	0,523	0,532	0,546	0,559	0,564	0,569	0,574	0,585	0,596
33°C	0,495	0,504	0,512	0,521	0,535	0,548	0,555	0,562	0,569	0,580	0,590
34°C	0,479	0,490	0,500	0,511	0,527	0,543	0,550	0,557	0,564	0,575	0,585
35°C	0,468	0,479	0,489	0,500	0,516	0,532	0,539	0,546	0,553	0,564	0,574
36°C	0,452	0,465	0,477	0,490	0,506	0,521	0,528	0,536	0,543	0,556	0,569
37°C	0,436	0,449	0,461	0,474	0,492	0,511	0,520	0,528	0,537	0,548	0,559
38°C	0,420	0,434	0,449	0,463	0,482	0,500	0,509	0,518	0,527	0,540	0,553
39°C	0,404	0,418	0,433	0,447	0,468	0,490	0,498	0,507	0,516	0,530	0,543
40°C	0,383	0,399	0,415	0,431	0,452	0,474	0,484	0,495	0,506	0,519	0,532
41°C	0,367	0,383	0,399	0,415	0,439	0,463	0,472	0,481	0,490	0,506	0,521
42°C	0,346	0,362	0,378	0,394	0,420	0,447	0,458	0,468	0,479	0,492	0,506
43°C	0,324	0,342	0,360	0,378	0,404	0,431	0,442	0,452	0,463	0,479	0,495
44°C	0,303	0,321	0,339	0,356	0,386	0,415	0,426	0,436	0,447	0,463	0,479
45°C	0,277	0,296	0,316	0,335	0,367	0,399	0,410	0,420	0,431	0,447	0,463

**Table 2.18 – Unitary cooling power ACF 60-00 version HR**

UNITARY COOLING POWER ACF60-00 version HR									
EXTERNAL AIR TEMPERATURE ( $T_a$ )	WATER DELIVERY TEMPERATURE ( $T_{cm}$ )								
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C	
	WATER RETURN TEMPERATURE ( $T_{cr}$ )								
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C	
	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]	$q_c$ [kW]
0°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
1°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
2°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
3°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
4°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
5°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	
6°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19	

UNITARY COOLING POWER ACF60-00 version HR								
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]	q <sub>c</sub> [kW]
7°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
8°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
9°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
10°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
11°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
12°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
13°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
14°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
15°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
16°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
17°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
18°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
19°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
20°C	17,20	17,28	17,36	17,54	17,72	17,89	18,07	18,19
21°C	17,16	17,27	17,36	17,54	17,72	17,89	18,07	18,19
22°C	17,12	17,25	17,36	17,54	17,72	17,89	18,07	18,19
23°C	17,09	17,23	17,36	17,54	17,72	17,89	18,07	18,19
24°C	17,05	17,21	17,36	17,54	17,72	17,89	18,07	18,19
25°C	17,02	17,20	17,36	17,54	17,72	17,89	18,07	18,19
26°C	16,77	17,05	17,33	17,52	17,72	17,89	18,07	18,19
27°C	16,52	16,91	17,30	17,50	17,72	17,89	18,07	18,19
28°C	16,28	16,77	17,27	17,49	17,72	17,89	18,07	18,19
29°C	16,04	16,63	17,23	17,47	17,72	17,89	18,07	18,19
30°C	15,79	16,49	17,20	17,45	17,72	17,89	18,07	18,19
31°C	15,27	16,13	17,00	17,37	17,72	17,89	18,07	17,98
32°C	14,74	15,77	16,79	17,26	17,72	17,89	18,07	17,78
33°C	14,16	15,38	16,56	17,16	17,72	17,89	18,08	17,58
34°C	13,57	14,99	16,36	17,05	17,72	17,89	18,07	17,37
35°C	12,94	14,57	13,13	16,95	17,72	17,90	18,07	17,18
36°C	\	\	\	\	17,57	17,72	17,87	16,96
37°C	\	\	\	\	17,41	17,53	17,67	16,77
38°C	\	\	\	\	17,23	17,35	17,45	16,53
39°C	\	\	\	\	17,05	17,15	17,24	16,33
40°C	\	\	\	\	16,84	16,94	17,01	16,12
41°C	\	\	\	\	16,36	16,52	16,65	15,99
42°C	\	\	\	\	15,87	16,09	16,27	15,82
43°C	\	\	\	\	15,34	15,64	15,88	15,67
44°C	\	\	\	\	14,78	15,17	15,47	15,50
45°C	\	\	\	\	14,17	14,67	15,06	15,36

Table 2.19 – GUE ACF60-00 unit version HR

GUE ACF60-00 version HR								
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
0°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
1°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
2°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
3°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
4°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
5°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
6°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
7°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
8°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
9°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
10°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
11°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
12°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
13°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728

GUE ACF60-00 version HR								
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER DELIVERY TEMPERATURE (T <sub>cm</sub> )							
	3°C	4°C	5°C	6°C	7°C	8°C	9°C	10°C
	WATER RETURN TEMPERATURE (T <sub>cr</sub> )							
	8°C	9°C	10°C	11°C	12°C	13°C	14°C	15°C
14°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
15°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
16°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
17°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
18°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
19°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
20°C	0,688	0,691	0,694	0,702	0,709	0,716	0,723	0,728
21°C	0,686	0,691	0,694	0,702	0,709	0,716	0,723	0,728
22°C	0,685	0,690	0,694	0,702	0,709	0,716	0,723	0,728
23°C	0,684	0,689	0,694	0,702	0,709	0,716	0,723	0,728
24°C	0,682	0,688	0,694	0,702	0,709	0,716	0,723	0,728
25°C	0,681	0,688	0,694	0,702	0,709	0,716	0,723	0,728
26°C	0,671	0,682	0,693	0,701	0,709	0,716	0,723	0,728
27°C	0,661	0,676	0,692	0,700	0,709	0,716	0,723	0,728
28°C	0,651	0,671	0,691	0,700	0,709	0,716	0,723	0,728
29°C	0,642	0,665	0,689	0,699	0,709	0,716	0,723	0,728
30°C	0,632	0,660	0,688	0,698	0,709	0,716	0,723	0,728
31°C	0,611	0,645	0,680	0,695	0,709	0,716	0,723	0,719
32°C	0,589	0,631	0,672	0,690	0,709	0,716	0,723	0,711
33°C	0,566	0,615	0,664	0,686	0,709	0,716	0,723	0,703
34°C	0,543	0,600	0,655	0,682	0,709	0,716	0,723	0,695
35°C	0,518	0,583	0,645	0,678	0,709	0,716	0,723	0,687
36°C	\	\	\	\	0,703	0,709	0,715	0,678
37°C	\	\	\	\	0,696	0,701	0,707	0,671
38°C	\	\	\	\	0,689	0,694	0,698	0,661
39°C	\	\	\	\	0,682	0,686	0,689	0,653
40°C	\	\	\	\	0,673	0,678	0,680	0,645
41°C	\	\	\	\	0,655	0,661	0,666	0,639
42°C	\	\	\	\	0,635	0,644	0,651	0,633
43°C	\	\	\	\	0,613	0,626	0,635	0,627
44°C	\	\	\	\	0,591	0,607	0,619	0,620
45°C	\	\	\	\	0,567	0,587	0,603	0,614

**Table 2.20 – Unitary recoverable heating power ACF 60-00 version HR**

UNITARY RECOVERABLE HEATING POWER ACF60-00 version HR							
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER RETURN TEMPERATURE AT RECOVERY CIRCUIT						
	20°C	30°C	40°C	50°C	60°C	70°C	
15°C	27,00	21,00	14,05	8,13	3,00	\	
16°C	27,40	21,38	14,44	8,50	3,34	\	
17°C	27,80	21,76	14,83	8,87	3,68	\	
18°C	28,20	22,14	15,22	9,24	4,02	\	
19°C	28,60	22,52	15,61	9,61	4,36	\	
20°C	29,00	22,90	16,00	9,98	4,70	\	
21°C	29,22	23,22	16,40	10,41	5,02	\	
22°C	29,44	23,53	16,80	10,84	5,33	\	
23°C	29,66	23,85	17,20	11,27	5,65	\	
24°C	29,88	24,16	17,60	11,70	5,96	\	
25°C	30,10	24,48	18,00	12,13	6,28	2,50	
26°C	30,34	24,61	18,22	12,35	6,53	2,70	
27°C	30,58	24,73	18,43	12,57	6,78	2,90	
28°C	30,82	24,86	18,65	12,78	7,02	3,10	
29°C	31,06	24,98	18,86	13,00	7,27	3,30	
30°C	31,30	25,11	19,08	13,22	7,52	3,50	
31°C	31,44	25,33	19,46	13,68	8,02	3,93	
32°C	31,58	25,55	19,85	14,14	8,51	4,36	
33°C	31,72	25,78	20,23	14,60	9,01	4,80	
34°C	31,86	26,00	20,62	15,06	9,50	5,23	
35°C	32,00	26,22	21,00	15,52	10,00	5,66	
36°C	\	26,58	21,40	15,92	10,36	5,93	
37°C	\	26,93	21,80	16,32	10,72	6,20	
38°C	\	27,29	22,20	16,73	11,08	6,46	

UNITARY RECOVERABLE HEATING POWER ACF60-00 version HR						
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER RETURN TEMPERATURE AT RECOVERY CIRCUIT					
	20°C	30°C	40°C	50°C	60°C	70°C
39°C	\	27,64	22,60	17,13	11,44	6,73
40°C	\	28,00	23,00	17,53	11,80	7,00
41°C	\	28,40	23,41	17,87	12,14	7,42
42°C	\	28,80	23,82	18,21	12,48	7,84
43°C	\	29,20	24,24	18,54	12,82	8,26
44°C	\	29,60	24,65	18,88	13,16	8,68
45°C	\	30,00	25,06	19,22	13,50	9,10

Table 2.21 – GUE ACF60-00 recovery circuit version HR

GUE ACF60-00 recovery circuit version HR						
EXTERNAL AIR TEMPERATURE (T <sub>a</sub> )	WATER RETURN TEMPERATURE AT RECOVERY CIRCUIT					
	20°C	30°C	40°C	50°C	60°C	70°C
15°C	1,080	0,840	0,562	0,325	0,120	\
16°C	1,096	0,855	0,578	0,340	0,134	\
17°C	1,112	0,870	0,593	0,355	0,147	\
18°C	1,128	0,886	0,609	0,370	0,161	\
19°C	1,144	0,901	0,624	0,384	0,174	\
20°C	1,160	0,916	0,640	0,399	0,188	\
21°C	1,169	0,929	0,656	0,416	0,201	\
22°C	1,178	0,941	0,672	0,434	0,213	\
23°C	1,186	0,954	0,688	0,451	0,226	\
24°C	1,195	0,967	0,704	0,468	0,239	\
25°C	1,204	0,979	0,720	0,485	0,251	0,100
26°C	1,214	0,984	0,729	0,494	0,261	0,108
27°C	1,223	0,989	0,737	0,503	0,271	0,116
28°C	1,233	0,994	0,746	0,511	0,281	0,124
29°C	1,242	0,999	0,755	0,520	0,291	0,132
30°C	1,252	1,004	0,763	0,529	0,301	0,140
31°C	1,258	1,013	0,779	0,547	0,321	0,157
32°C	1,263	1,022	0,794	0,566	0,340	0,175
33°C	1,269	1,031	0,809	0,584	0,360	0,192
34°C	1,274	1,040	0,825	0,602	0,380	0,209
35°C	1,280	1,049	0,840	0,621	0,400	0,226
36°C	\	1,063	0,856	0,637	0,414	0,237
37°C	\	1,077	0,872	0,653	0,429	0,248
38°C	\	1,092	0,888	0,669	0,443	0,259
39°C	\	1,106	0,904	0,685	0,458	0,269
40°C	\	1,120	0,920	0,701	0,472	0,280
41°C	\	1,136	0,936	0,715	0,486	0,297
42°C	\	1,152	0,953	0,728	0,499	0,314
43°C	\	1,168	0,969	0,742	0,513	0,330
44°C	\	1,184	0,986	0,755	0,526	0,347
45°C	\	1,200	1,002	0,769	0,540	0,364



## 3 PLANT DESIGN

### 3.1 GENERAL DESIGN CRITERIA

#### Types of plant

Absorption units can be used effectively with all types of hydronic heating and conditioning plant. Note, however, that since these systems are of very high efficiency, it is advisable to evaluate the use in the winter of vector fluid temperatures  $T_{hm}$  in the medium to low range, in other words, in the range to 30°C - 50°C. The use of medium to high temperature in the range to 50°C - 60°C, or even with peaks of 65°C (for the GAHP-A version HT), should be reserved for plants equipped with not particularly efficient heat delivery units, for which it is essential never to drop below a delivery temperature of 50°C. To this end, we note the option of reducing the delivery temperature to radiators in three situations: a) increased hours of operation of the heating system; b) reduced energy requirement of the building (improved building insulation); c) modified radiators (increased exchange surfaces).

#### Inertial volume

The inertial tank, although specifically required, can be usefully included in the circuit as a thermal energy accumulator when the water delivery temperature is less than or equal to 50°C, thus reducing the number of ignition cycles of the units composing the system. The volume in litres of the inertial tank can be determined using the following formula, in which  $t$  is the accumulation time in seconds,  $\dot{Q}_s$  is the heating power in kW transferred to the accumulation tank in the time  $t$ ,  $\rho$  is the density of the vector fluid in use,  $C_p$  is the specific heat of the water (4.187 kJ/kg K) and  $\Delta T$  is the thermal differential of the vector fluid expressed in degrees Kelvin (K).

$$V = \frac{\dot{Q}_s}{\rho \cdot C_p \cdot \Delta T} \cdot t \quad (I)$$

A simple way of determining the power  $\dot{Q}_s$ , is to select the minimum seasonal load factor  $F_c$  and apply it in the following formula:

$$\dot{Q}_s = \dot{Q}_h - \left( \dot{Q}_h \cdot F_c \right) \quad (\text{kW})$$

Where the heating power  $\dot{Q}_h$  is the heating power delivered by the installed unit.  $F_c$  is the minimum seasonal load factor calculated as follows:

$$F_c = \frac{\dot{Q}_{hm}}{\dot{Q}_h} = \frac{T_i - T_{am}}{T_i - T_a}$$

where:

$T_i$  is the internal air temperature of the heated rooms

$T_a$  is the design external temperature

#### Production of domestic hot water

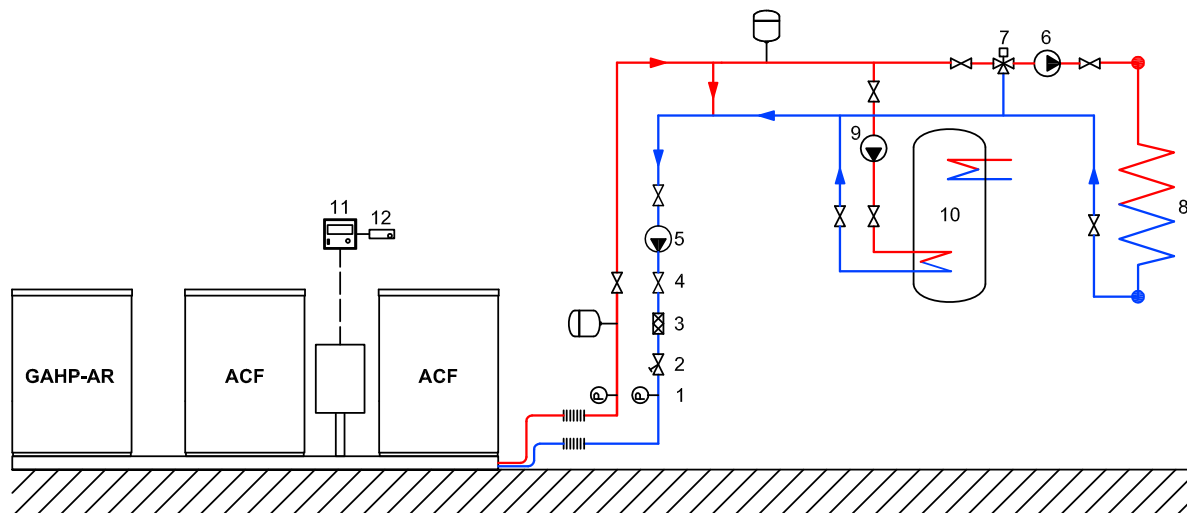
Domestic hot water (DHW) can be produced by pre-assembled units, in a variety of types of plant.

In the RTAR and RTCR configurations, which do not include AY condensing modules nor ACF HR chillers with recovery circuit, the production of DHW can only be done in winter

operation mode and in the context of the maximum condenser return temperature (50°C). One should thus implement an accumulation system with temperature close to the service temperature (e.g. 45°C) or a system with heat exchanger at the same working temperature. In any case, a supplementary system should be installed (second coil), to provide hot water during the summer, when the heat pump cannot provide heating power. Such equipment should also provide a thermal shock cycle for the “anti-legionella” service.

In Figure 3.1 Schematic for the use of a single GAHP-AR for production of domestic hot water at max 45°C → 100 we give an example of an RTCR 180-120 SC (without circulators) combined with an air conditioning and domestic hot water production plant with accumulator. The heat pump, when DHW production is not required, sends the vector fluid to the plant at the requested conditions of use. When the boiler requires power for domestic hot water production in the winter the RB100 system interface, supplied by Robur, in combination with the DDC, raises the unit’s setpoint to satisfy the temporary request from the boiler. A three-way mixer valve controls the delivery temperature to the radiator coils.

**Figure 3.1** – Schematic for the use of a single GAHP-AR for production of domestic hot water at max 45°C



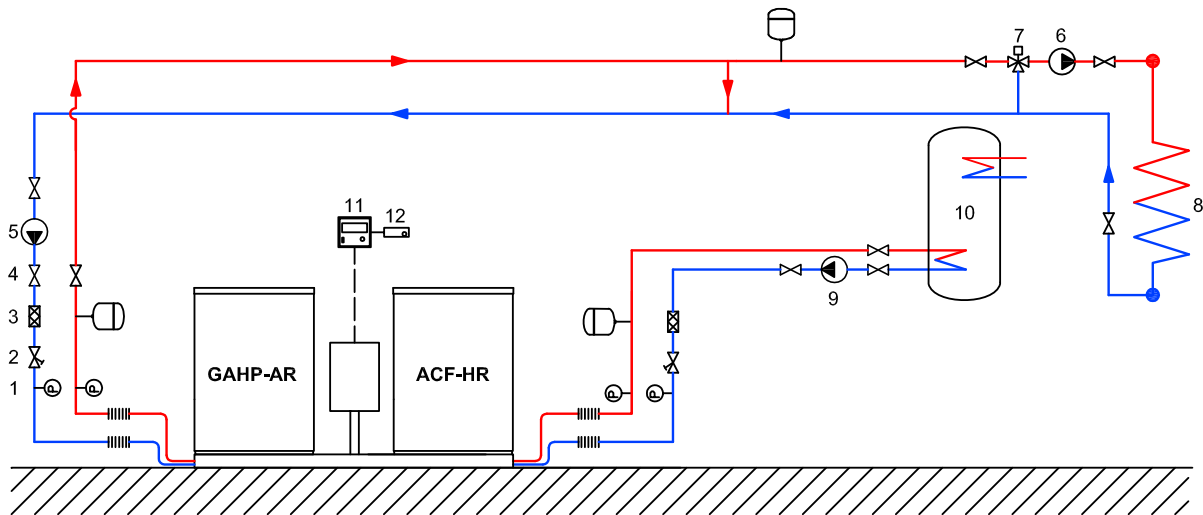
In the schematic given in Figure 3.1 Schematic for the use of a single GAHP-AR for production of domestic hot water at max 45°C → 100 the represented components have the following meanings: “1” pressure gauge; “2” flow regulator valve; “3” water filter; “4” check valves; “5” internal circuit constant rate pump; “6” external service circuit constant rate pump; “7” three-way regulator/mixer valve; “8” heating system services; “9” DHW production external circuit constant rate pump; “10” boiler for DHW production; “11” direct digital controller DDC; “12” RB100 system interface.

In the RTAH and RTHF configurations, which do not include AY condensing modules but do include ACF HR chillers with recovery circuit, the production of DHW can be done in both winter operation mode (for the RTAH units) and in the summer. In winter operation, the parameter to be considered is the maximum condenser return temperature (50°C). In the summer, the heat recovery circuit of the ACF HR chillers can be used to produce heating power (with the thermal efficiency indicated in 50°C Table 2.20 Unitary recoverable heating power ACF 60-00 version HR → 96) for use in producing domestic hot water, either directly or by preheating. The choice depends on the temperature (and consequent flow rate, since the heating energy delivery is determined by the unit’s ambient conditions) at which the energy source, provided free of charge by the unit, is to be exploited. It is thus possible to implement an accumulation heating system with temperatures close

to those in actual use (e.g. 45°C) or a system with preheating and subsequent reheating to the temperature of use by a conventional boiler or solar panels. IN any case, an alternative system must be provided (second coil powered by a conventional boiler or equivalent), to provide the DHW service when the absorption units are switched off or in use for conditioning, or when the ACF HR chiller is not active and thus cannot provide recovery heat. Such equipment should also provide a thermal shock cycle for the “anti-legionella” service.

In Figure 3.2 Plumbing schematic for use of recovered thermal energy in domestic hot water preheating in the summer → 101 we give an example of an RTAH 120-120 CC (with circulators) combined with an air conditioning and domestic hot water production plant with accumulator and double coil. In the winter, the heat pump, when DHW production is not required, sends the vector fluid to the plant at the requested conditions of use. When the boiler requires power for domestic hot water production the RB100 system interface, supplied by Robur, in combination with the DDC, raises the unit's setpoint to satisfy the temporary request from the boiler. A three-way mixer valve controls the delivery temperature to the radiator coils. During the summer, the controller will give priority to the ACF HR chillers so as to provide the heating power required for DHW pre-heating, which is supplemented, when necessary, to achieve the design conditions at the accumulator outlet and for execution of the anti-legionella thermal shock cycle.

**Figure 3.2** – Plumbing schematic for use of recovered thermal energy in domestic hot water preheating in the

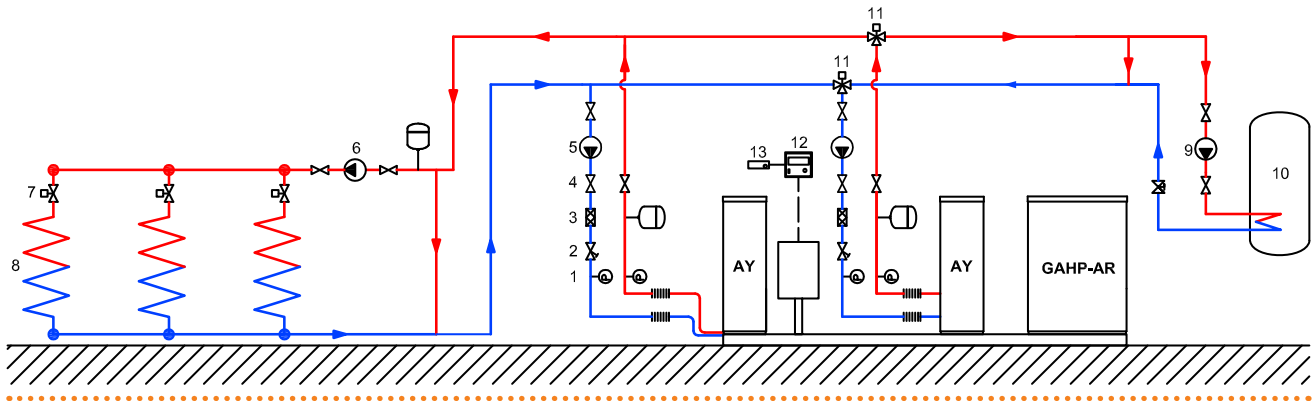


In the schematic given in Figure 3.2 Plumbing schematic for use of recovered thermal energy in domestic hot water preheating in the summer → 101 the represented components have the following meanings: “1” pressure gauge; “2” flow regulator valve; “3” water filter; “4” check valves; “5” internal circuit constant rate pump; “6” external service circuit constant rate pump; “7” three-way regulator/mixer valve; “8” heating system services; “9” DHW preheating circuit constant rate pump; “10” double coil boiler for DHW production; “11” direct digital controller DDC; “12” RB100 system interface.

In the RTY, RTRC, RTYR, RTYF and RTAY configurations, which include AY condensing modules but do not include ACF HR chillers with recovery circuit, the production of DHW can be done in any operating mode, thanks to the presence of the condensing modules. In this case, it is advisable to use the 4-pipe versions, since this ensures DHW production independently of the operation of the absorption units. In this condition one can supply an accumulation boiler with water at the desired temperature (the only limit is constituted

by the maximum boiler return temperature, which is equal to 70°C), and thus easily reach temperatures which make any further anti-legionella treatment unnecessary. In Figure 3.3 Hydraulic schematic for a mixed heating and DHW production system → 102 we give an example of a single RTYR 60-360 CC (with circulators) unit in the 4-pipe version combined with a heating system with radiant panels and domestic hot water production plant with accumulator.

**Figure 3.3** – Hydraulic schematic for a mixed heating and DHW production system



In the schematic, the represented components have the following meanings: "1" pressure gauge; "2" flow regulator valve; "3" water filter; "4" shut-off valve; "5" internal circuit constant rate pump; "6" external service circuit variable rate pump; "7" 2-way regulator valve; "8" heating system services; "9" hot water production external circuit constant rate pump; "10" boiler for domestic hot water production; "11" diverter valve for excluding the AY boiler; "12" Direct Digital Controller; "13" RB100 system interface. The present schematic does not include the ISPEL ramps inasmuch as they are not required for AY condensing boilers.

The plant represented in Figure 3.3 Hydraulic schematic for a mixed heating and DHW production system → 102, provides not only normal heating and conditioning services, but also DHW production in all seasons of use by one of the condensing boilers in the circuit. When needed, when the DHW boiler requires it, the RB100 system interface actuates the diverter valves (position 12) and, when a limit signal notifies the interface that deviation of flow towards the boiler has been completed, it varies the setpoint (if required) of the single Robur AY condensing boiler used for the operation, which is disconnected from the heating circuit until the DHW production service has terminated.

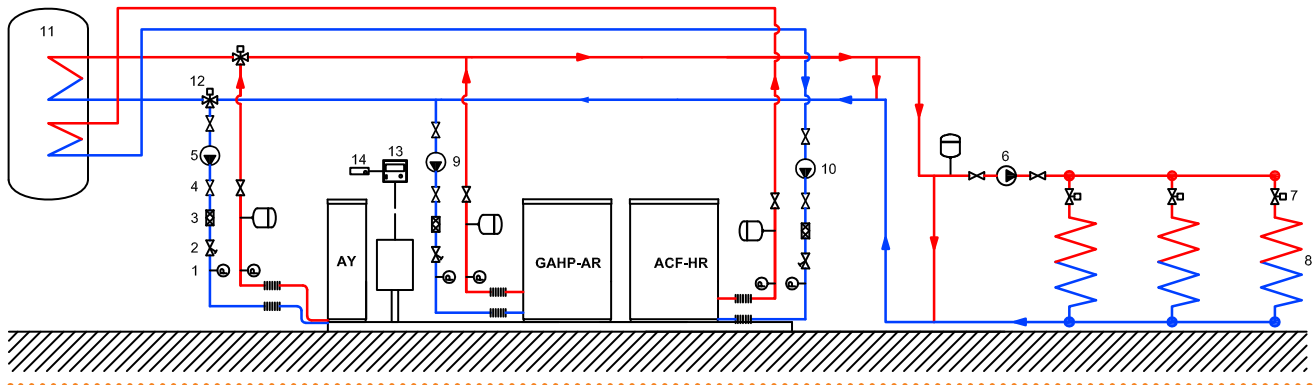
In the RTRH and RTYH configurations, which include both AY condensing modules and ACF HR chillers with recovery circuit, the production of DHW can be done in any operating mode, thanks to the presence of the condensing modules. In summer mode, the recovered heat can be used for pre-heating the water in the accumulation boiler, thus reducing module trip cycles and, consequently, running costs.

In this case, it is advisable to use the 6-pipe versions, since this ensures DHW production independently of the operation of the absorption units, while also allowing the simultaneous use of the recovery circuit hot water in other ways (DHW pre-heating, DHW production for swimming pool heating, etc.). In this condition one can supply an accumulation boiler with water at the desired temperature (the only limit is constituted by the maximum boiler return temperature, which is equal to 70°C), and thus easily reach temperatures which make any further anti-legionella treatment unnecessary.

In Figure 3.4 Hydraulic schematic for a mixed heating and DHW production system with summer pre-heating → 103 we give an example of a single RTRH 118-240 CC (with circu-

lators) unit in the 6-pipe version combined with a heating system with radiant panels and domestic hot water production plant with accumulator with double-coil boiler.

**Figure 3.4** – Hydraulic schematic for a mixed heating and DHW production system with summer pre-heating



In the schematic, the represented components have the following meanings: "1" pressure gauge; "2" flow regulator valve; "3" water filter; "4" check valves; "5" AY boiler internal circuit constant rate pump; "6" external service circuit variable rate pump; "7" 2-way regulator valve; "8" heating system services; "9" heat pump internal circuit constant rate pump; "10" recovery hot water circuit constant rate pump; "11" boiler for DHW production; "12" diverter valve for excluding the AY boiler; "13" direct digital controller DDC; "14" RB100 system interface. The present schematic does not include the ISPEL ramps inasmuch as they are not required for AY condensing boilers.

The plant represented in Figure 3.4 Hydraulic schematic for a mixed heating and DHW production system with summer pre-heating → 103 provides not only normal heating and conditioning services, but also DHW production in all seasons of use by one of the condensing boilers in the circuit.

When needed, when the DHW boiler requires it, the RB100 system interface actuates the diverter valves (position 12) and, when a limit signal notifies the interface that deviation of flow towards the boiler has been completed, it varies the setpoint (if required) of the single Robur AY condensing boiler used for the operation, which is disconnected from the heating circuit until the DHW production service has terminated.

### Characteristics of the plant water supply

Robur units, by their very nature, do not require evaporator towers to operate. There is thus no need for topping up the water circuit. Furthermore, for the same reason, there are no special requirements or restrictions on the plant water quality, so that one need only refer to the normal values adopted for the physical and chemical properties of vector fluids in traditional conditioning and heating systems.

You need only observe established standards regarding the treatment of water for heating/cooling systems.

The optimal chemical and physical specifications for the water are given in Table 3.1 Chemical and physical parameters of water → 103.

**Table 3.1** – Chemical and physical parameters of water

CHEMICAL AND PHYSICAL PARAMETERS OF WATER IN HEATING/COOLING SYSTEMS		
PARAMETER	OPTIMAL VALUE	UNIT OF MEASUREMENT
pH	6,5 - 8,0	\
Chlorides	< 125	mg/L
Total chlorine	< 5	mg/L
Total hardness (CaCO <sub>3</sub> )	10 - 15	°F
Iron	< 50	mg/L
Copper	< 3	mg/L
Aluminium	< 3	mg/L

Langelier's index	0	\
<b>SUBSTANCES HAZARDOUS EVEN AT VERY LOW CONCENTRATION</b>		
Free chlorine	ABSENT	
Fluorides	ABSENT	
Sulphides	ABSENT	

Physical and chemical properties of the system water.

### 3.2 INSTALLATION CRITERIA

- Pre-assembled units must be installed outdoors, in an area in which air circulates naturally and which does not require any particular protection from the weather. **The units may not under any circumstances be installed indoors.**
- No obstruction or overhanging structure (protruding roofs, eaves, balconies, ledges, trees) may obstruct the flow of air from the top of the appliance, nor the combustion fumes exhaust.
- Do not install the units in the immediate vicinity of flue outlets, chimneys or other such features, so as to prevent warm or polluted air from being drawn in by the fan via the condenser. In order to function correctly the units must use clean air from the environment.
- They must be installed in such a way that the exhaust fumes outlet is not in the immediate vicinity of any external air inlets of a building. Observe established standards in regard to the discharge of fumes.
- If the units are to be installed in the vicinity of constructions, make sure that it is out of the way of water dripping from gutters or similar sources.
- The absorption units are homologated for connection of their combustion products evacuation pipe to a flue for direct connection to the exterior of type B23 and B53. Each GAHP-AR module is equipped with a fitting of diameter Ø 80 mm while each AY condensing module is equipped with a fitting of diameter Ø 80 mm (each of them are fitted with gaskets). If the type of installation or established legislation requires combustion products to be conveyed away, refer to the instructions given in Paragraph 1.13 PRESSURE DROPS → 76 for the correct dimensions of the duct in relation to the characteristics of each module composing the unit.
- The fumes flue, if present, and the fumes duct, must be dimensioned for operation with natural or forced draw in relation to the residual head available at the flue outlet. In the case of condensing units (AY condensing and GAHP-A), the flue and its fumes duct must be constructed in polypropylene and the high residual head (80 Pa) makes it possible to find an optimal discharge solution without difficulty.
- Each unit which has more than 2 condensing units is equipped with a condensation collection and conveyance system, which must be connected to the discharge circuit by the installer. If local legislation permits, it can be discharged directly into the sewers, otherwise a system to neutralise the condensation before disposal must be installed. Depending on the type of installation it may also be necessary to install a condensation return pump, available from Robur.

#### Plumbing plant and gas circuit

- The sizing of the plumbing pipes and pump must guarantee the nominal water flow required for correct operation of the pre-assembled unit (for calculation of pressure drops in pre-assembled units, refer to Paragraph 1.13 PRESSURE DROPS → 76).
- The hydraulic plant may be created using pipes in stainless steel, black steel, copper or crosslinked polyethylene for heating/cooling plants. All water pipes and pipe connections must be adequately insulated in accordance with current regulations, to prevent heat loss and the formation of condensate.

- When rigid pipes are used, in order to prevent the transmission of vibrations, we recommended connecting the water inlet and outlet of the appliance with anti-vibration joints.
- When filling the hydraulic circuit, ensure the minimum water content in the plant, and add, in case of outdoors installation, to the plant water (free of impurities) a quantity of inhibited monoethylene glycol in proportion with the minimum winter temperature in the installation zone (see Table 3.2 Percentage of monoethylene glycol → 105).
- To prevent icing inside the circuit, the units are equipped with antifreeze equipment. This device (antifreeze function) starts the external water circulation pump (if controlled by the unit) and, if necessary, the burner (in heating mode). It is therefore necessary to ensure a continuous supply of electricity and gas to the appliance throughout the whole of the winter period. If it is not possible to ensure a continuous supply of electricity and gas to the appliance, use glycol antifreeze of the inhibited monoethylene type.
- If glycol antifreeze is to be used, DO NOT USE galvanised pipes, as they are potentially subject to corrosion in the presence of glycol. Table 3.2 Percentage of monoethylene glycol → 105 following, we give the approximate freezing temperature of the water and consequent increased drop in pressure of the appliance and system circuit as a function of the percentage of monoethylene glycol employed. This table should be taken into account for the sizing of the pipes and the circulation pump (for calculation of internal pressure drops of the appliance, refer to Paragraph 1.13 PRESSURE DROPS → 76).
- Nevertheless, it is advisable to consult the technical specifications of the monoethylene glycol used.

**Table 3.2** – Percentage of monoethylene glycol

% of MONOETHYLENE GLYCOL	10	15	20	25	30	35	40
WATER FREEZING POINT TEMPERATURE	-3°C	-5°C	-8°C	-12°C	-15°C	-20°C	-25°C
PERCENTAGE OF INCREASE IN PRESSURE DROPS	--	6%	8%	10%	12%	14%	16%
LOSS OF EFFICIENCY OF UNIT	--	0,5%	1%	2%	2,5%	3%	4%

Technical data for filling the hydraulic circuit

- The pressure of the gas supplied by the mains must be within the range of 17 and 25 mbar for natural gas (G20), and between 25 and 35 mbar for LPG (whether G30 or G31).
- The gas supply system must be correctly rated for the capacity required by the appliance and must be equipped with all safety and control devices prescribed by current regulations.
- Clean the plant of any waste or process residue before commissioning the units, to prevent the filters blocking and reducing the circulation of water.

### 3.3 POSITIONING THE PRE-ASSEMBLED UNIT

#### Lifting and positioning

Pre-assembled units can be installed at ground level, or on a terrace or roof (if they are able to sustain its dimensions and weight, see the section "1 OVERVIEW AND TECHNICAL CHARACTERISTICS → 5" for the unit in question).

The hoist and all accessory equipment (braces, cables, bars) must be of adequate dimensions in relation to the load to be lifted.

### **Supporting base**

Always position the appliance on a flat level surface that is made of fireproof material and able to sustain the weight of the appliance itself.

During winter operation, the appliance, on the basis of temperature and humidity conditions of the outside air, can carry out defrosting cycles that cause the layer of frost/ice on the fan coil to melt.

Take this possibility into consideration, adopting appropriate measures (for example: a "containing" step and channelling of water into a suitable drain) in order to prevent "uncontrolled" spread of water around the appliance and the consequent risk that a layer of ice will form (with the danger of falls on the part of passing people).

Robur S.p.A. is not liable for any damages resulting from failure to observe this warning.

### **Installation at ground level**

If a horizontal support base is unavailable (see also "SUPPORTS and LEVELLING" below), it is necessary to create a flat level base in concrete which is larger than the dimensions of the base of the appliance by at least 100-150 mm on each side.

The dimensions of the pre-assembled units are given in the section "1 OVERVIEW AND TECHNICAL CHARACTERISTICS → 5".

Provide a "containing" step and a suitable drainage channel for the water.

### **Installation on a terrace or roof**

Position the appliance on a levelled flat surface made of fireproof material (see also "Supports and levelling" below).

The structure of the building must be able to sustain the weight of the appliance added to that of the supporting base.

The weights of the pre-assembled units are given in the Section "1 OVERVIEW AND TECHNICAL CHARACTERISTICS → 5".

Make sure to install a containment area which conveys the water to a drain inlet, as well as a maintenance walkway around the appliance.

Although the appliance produces only moderate vibrations, the use of anti-vibration supports (available as accessories) is especially recommended in rooftop and terrace installations in which resonance phenomena may occur.

In addition, it is advisable to use flexible connections (anti-vibration joints) between the appliance and the hydraulic and gas supply pipes.

### **Supports and levelling**

The appliance must be correctly levelled by placing a level on its top surface.

If necessary, level the appliance with metal shims, placing them appropriately in relation to the mounts; do not use wooden spacers as these degrade quickly.

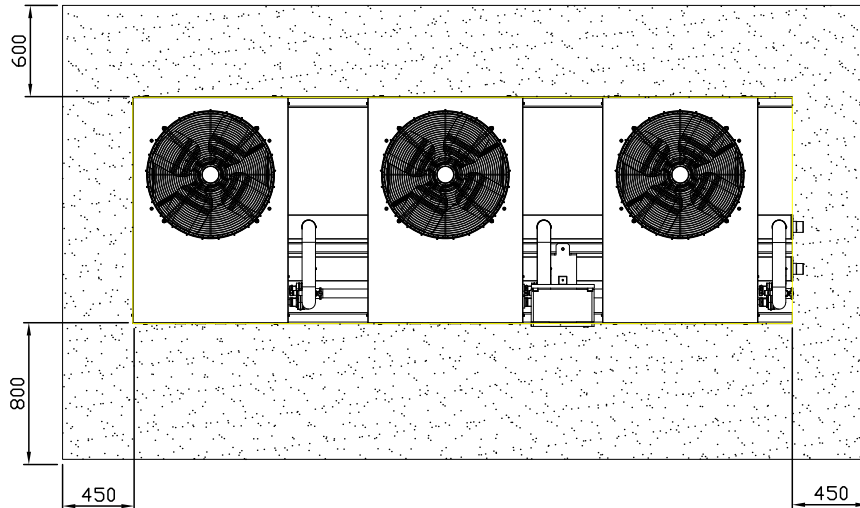
### **Clearances**

Locate the appliance in such a way as to maintain the minimum specified clearances from combustible surfaces, walls or other equipment, as given in Figure 3.5 → 107.

Minimum clearances are necessary in order to be able to carry out maintenance operations and to ensure the correct airflow required for heat exchange with the finned coil.

If special installations are required (trench, niche, etc.), consult with Robur S.p.A. for the clearances required.

Figure 3.5



Minimum clearances (dimensions in mm)

Evaluate the noise impact of the appliance in relation to the installation site: avoid installing the appliance in positions (corners of buildings, etc.) that could amplify its running noise (reverb effect), and always check the consequences of the intended installation position.

### 3.4 HYDRAULIC PLANT COMPONENTS

The components described below, to be fitted in proximity to the appliance, are illustrated in the typical hydraulic plant schematics in section "6 PLANT SCHEMATICS → 117":

- ANTIVIBRATION JOINTS in line with the water and gas connections of the appliance.
- MANOMETERS installed in the inlet and outlet water pipes.
- FLOW REGULATION VALVE (shutter or balancing) at the water inlet pipe.
- WATER FILTER at the water inlet pipe, mesh MIN 0.7 mm, MAX 1 mm.
- ISOLATION BALL VALVE in the water and gas pipes of the plant.
- 3 BAR SAFETY VALVE installed in the appliance outlet water pipe.
- EXPANSION TANK on the water outlet pipe.
- PLANT WATER CIRCULATION PUMP on the water inlet pipe, rated for the installation in question.
- Systems for BLEEDING AIR from the water pipes, located at the top of the appliance circuit.
- DRAIN COCK on the water pipes.
- PLANT FILLING SYSTEM: if automatic filling systems are used, it is advisable to carry out a seasonal check of the percentage of monoethylene glycol contained in the plant.
- CONDENSATION COLLECTION AND DISPOSAL SYSTEM connected to the condensation drain provided on the unit, complete with eventual neutralisation system as per established legislation and eventual condensate pump.

If more than one unit is connected to a single hydraulic circuit, the following must also be installed:

- WATER CIRCULATION PUMP for each unit, on the water inlet pipe, with delivery towards the GAHP-WS unit, rated for the installation in question (except for units provided with independent circulators as standard - CC configuration).
- HYDRAULIC SEPARATOR complete with air bleeder valve and drain tap.

- PLANT WATER CIRCULATION PUMP on the plant delivery pipe, with delivery towards the plant.

## 4 ELECTRICAL DESIGN

The following specifications must be observed in the electrical power section of the plant:

- Power supply 400 V 3N - 50 Hz or, alternatively, 230 V 1N - 50 Hz.
- The electrical components used for the hookup (circuit breakers, fuses, relays, etc.) must be mounted in an external electrical cabinet located by the installer in the vicinity of the pre-assembled unit.
- If the plant is equipped with a hydraulic separator, take the precautions required to prevent the external circuit water freezing during the winter (for example, control the operation of the external circuit circulation pump with a lock or thermostat).

**N. B.: The electrical safety of the appliance is guaranteed only when it is correctly connected to an efficient grounding system, executed in accordance with current safety regulations. Do not use gas pipes to ground electrical appliances.**

**The electrical connection schematics are given in Section "6 PLANT SCHEMATICS → 117".**

### 4.1 CONNECTIONS TO THE PRE-ASSEMBLED UNITS

To hook up one or more pre-assembled units, the following will be required:

- A connection cable, FG7(O)R 5Gx4.
- An external four- or two-pole circuit breaker with 3 fuses with minimum airgap 3 mm or a thermal cutout.

### 4.2 CONNECTING THE CONTROLLER

The pre-assembled units can be controlled with the standard accessory Direct Digital Controller (DDC).

For a total cable run of  $\leq 200$  m and up to 5 single units connected (composing the pre-assembled unit), use a simple 3x0.75 mm<sup>2</sup> shielded cable; otherwise use a CAN-BUS cable as specified by the Honeywell SDS standard, as given below:

- Robur Netbus (Robur, maximum cable run 450 m).
- Belden 3086A (Honeywell SDS 1620, maximum cable run 450 m).
- Turck 530 (Honeywell SDS 1620, maximum cable run 450 m).
- Turck 5711 (DeviceNet Mid Cable, maximum cable run 450 m).
- Turck 531 (Honeywell SDS 2022, maximum cable run 200 m).



## 5 REGULATOR SYSTEM

### 5.1 DIRECT DIGITAL CONTROLLER (DDC)

The fundamental component for the control and regulation of the units is the Direct Digital Controller (DDC).

The Direct Digital Controller is a device which displays, on a backlit graphic LCD display of 128x64 pixels, all the status, operating and error conditions of each individual unit to which it is linked. The DDC controls water thermostating by controlling the switch-on and switch-off of the units connected to it.

Each DDC is able to control up to sixteen GAHP-WS modules, beyond which another DDC must be used in combination with the first to control the system.

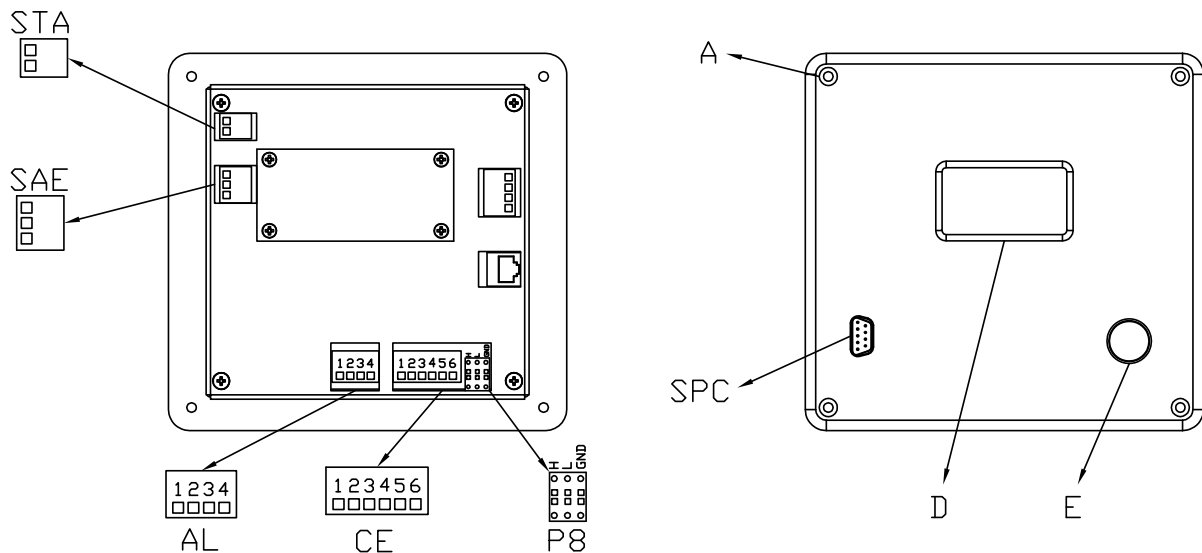
For pre-assembled units, the DDC is standard supply (one per unit).

The DDC is designed for indoors installation (ambient air temperature in the range to 0°C 50°C), mounted to an electrical cabinet in a hole measuring 155 x 151 mm.

The front of the DDC mounts a graphic display on which all the parameters necessary to control, program and configure the plants managed by the DDC are shown (see detail D, Figure 5.1 Direct Digital Control (DDC) → 111); a selector knob (Encoder) used to communicate with the DDC and select options, parameter settings, etc. (detail E, Figure 5.1 Direct Digital Control (DDC) → 111); an RS 232 serial port for connecting the DDC to a PC (see detail SPC, Figure 5.1 Direct Digital Control (DDC) → 111), used for technical service.

The rear of the DDC mounts all the electrical and CAN-BUS connections required for its operation. Furthermore, it also features voltage free contacts for additional DDC on/off options using enabling signals from external regulator systems, alarm lamps and buzzers for remote installation, and contacts for connection to an ambient sensor (optional).

**Figure 5.1** – Direct Digital Control (DDC)



#### LEGEND

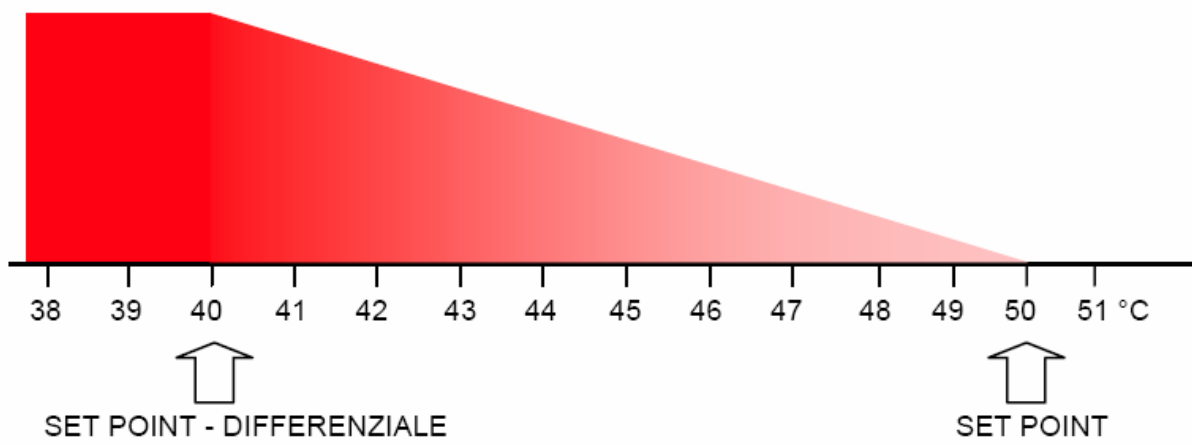
STA	ambient temperature probe - 2-pole connector
SAE	external alarm systems - 3-pole connector
AL	power supply 24 V ac - 4-pole connector
CE	external consents - 6-pole connector
P8	CAN BUS network connector (orange)
SPC	232 serial connection to PC - 9-pole connector
A	mounting holes DDC
E	Encoder
D	Display

Front and rear views with detail of electrical connections.

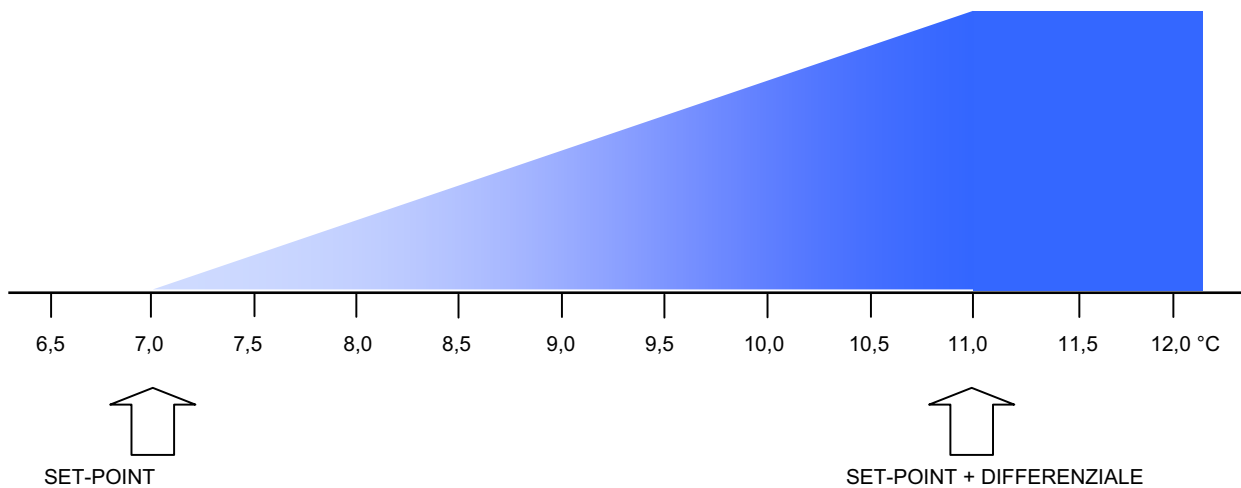
## 5.2 CONTROL AND REGULATION OF THE SYSTEM

For the control and regulation of the system, install one or more DDC's, which serve to obtain full system diagnostics and control and regulate the operation of the system itself. In particular, they are used to set the winter-time vector fluid differential and setpoint, with the option to control either the delivery or return temperature. The above settings can be made for four daily time bands, with the option of using four different setpoints. The Robur plant concept, which also includes multiple units, has the certain benefit of enabling completely independent operation of the component modules, so as to deliver the cooling/heating power strictly required to handle the real time load, thus preventing frequent operational variations and consequent wasted fuel consumption. Installation of units in cascade, up to five power steps, is featured on the DDC.

**Figure 5.2** – Example of winter operation power steps



**Figure 5.3** – Example of summer operation power steps



The regulation system, during the first daily power on, powers up all modules, which are then gradually switched off starting from the setpoint temperature minus the differential set on the DDC.

The system does not provide for sensors on the plant delivery or return pipes, since the pre-assembled units are equipped with sensors which enable direct measurement on-board of the vector fluid temperature.

### 5.3 "DEFROSTING"

During normal winter operation, it may happen that the finned array of the ices up with the humidity in the air. Contrary to what is the case in "air-water" electric heat pump appliances, the individual absorption unit of the pre-assembled unit automatically runs a defrost cycle, while continuing to provide heating to the plant (the system does not undergo cycle inversion).

The on-board electronics deviate part of the flow of ammoniac originating from the generator at a temperature close to that of the finned array, thus detaching the layer of ice. The heating power required for the heating plant is still provided by a part of the flow of ammoniac which continues to be sent to the tube coil heat exchanger in which the exchange of heat with the plant water occurs 80°C

Tests run on systems with pre-assembled units have shown that the number of defrosting cycles does not exceed 50 per winter season and that each cycle lasts an average of 3 minutes thanks to the high condensation temperature of the ammoniac. In short, the defrosting cycles do not compromise the overall efficiency of the heat pump.

### 5.4 "SLIDING TEMPERATURE"

The Pre-assembled unit (LINK) delivery/return temperature can be regulated continuously as a function of an external parameter controlled by another electronic system. In particular, it may be useful to vary the vector fluid delivery temperature as a function of the external air temperature, or another plant parameter which is significant in the application in question.

This option is provided by the optional RB100 plant interface, connected by a can-bus cable to the DDC. The RB100 can receive a 0 ÷ 10 V digital signal from an electronic regulator, so as to continuously modulate the delivery or return temperature.

The RB100 device has the function of interfacing the requests coming from one or more external control systems with the DDC.

It has the following functions: it controls the connected Robur units with a continuously variable temperature setpoint (sliding temperature) as well as domestic hot water production, which also requires actuation of the three-way diverter valves (see also Paragraph 5.5 CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION → 113).

RB100 board dimensions: width 158 mm, depth 74.6 mm height 106.5 mm. The weight of the component is 0.320 kg and it must be mounted to the cabinet on a 35 mm DIN rail (EN 60715).

### 5.5 CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION

The domestic hot water production service can be provided using only the component GAHP-AR units when the system includes medium to low temperature accumulator boilers (45°C - 48°C) or when the production is handled directly by suitably dimensioned heat exchangers (external circuit delivery temperature 45°C - 48°C).

This service is however only available in the winter, while during the summer a boiler specifically intended for this service will be required.

If the plant is to be equipped with one or more absorption Pre-assembled unit (LINK) in combination with AY condensation boilers, this service can be provided at any temperature of the DHW production boilers (accumulation temperature greater than 50°C) and in any season, using the condensation boilers for this purpose.

In this case it is advisable that the pre-assembled units be in the 4 or 6-pipe versions (the latter if an ACF HR chiller with heat recovery is also included), with the boiler fittings connected to a manifold specifically dedicated to DHW production.

In any case, in order to use absorption heat pumps to produce DHW, the controller must be equipped with a DDC and an "RB100" system interface.

If GAHP-AR heat pumps are to be used for producing DHW under the above-mentioned conditions (accumulation temperature close to user temperature - max 48°C), the RB100 is required to raise the unit's delivery temperature, if this is not already set to the maximum working temperature.

If Robur AY condensing boilers are also to be used (4- or 6-pipe version), the RB100 module connected with a CAN-BUS cable to the DDC can be used to deviate the vector fluid flow from the latter to a heat exchanger for direct or accumulation production of DHW. This is done by directly controlling the two dedicated 3-way diverter valves (not supplied by Robur S.p.A.).

Once the heating circuit has been deviated to DHW production, the RB100 module modifies the setpoint only of the Robur AY condensing boilers involved in this service. The adjustment of the DHW setpoint of the Robur AY condensing boilers can be done with an ON-OFF analogue signal originated by a thermostat, or by a 0 - 10 V digital signal from an electronic controller.

The advantage of the RB100 unit is that there is no need to include other boilers for DHW production, so that all the Robur AY condensing units can be used, which would otherwise be kept switched off most of the time during the winter.

Clearly the DHW production service has operational priority, so that if the system is operating under maximum design conditions, the boilers dedicated to the dual service will nonetheless be switched from heating mode to DHW production for the duration of the period for which the service is required.

For existing plant for which the user wishes to implement such a remote control system, the firmware must be compatible with the components - contact Robur S.p.A. presales.

## **5.6 REMOTE CONTROL - "WISE" (WEB INVISIBLE SERVICE EMPLOYEE)**

The WISE unit provides remote control of the major functions of the DDC and thus of the Robur units and plant controlled by the latter, over a common cellphone line equipped with WAP browser or using a point-to-point connection with a PC with a PSTN or GSM modem, so as to implement tele-control and teleassistance applications. The system is controlled by means of a web browser, while alarms are sent to the user by SMS.

The WISE device is composed of: n.1 WISE device; n.1 antenna; n.1 RS232 null-modem serial cable for device configuration; n.1 WISE - DDC communications cable with phone plug connection to the rear of the DDC; n.1 CD-ROM.

For existing plant for which the user wishes to implement such a remote control system, the firmware must be compatible with the components - contact Robur S.p.A. presales.

## **5.7 MOD BUS**

The DDC supports interfacing with external equipment (BMS, PLC, SCADA, etc.) via the Modbus RTU protocol.

The Modbus protocol makes it possible to acquire data regarding the operation of the units and the plant controlled by the DDC (temperatures, statuses, counters, etc.).

It can also acquire information regarding alarms, both current and registered in the alarms log.

It can also act on the plant to set a variety of operational parameters such as unit On/Off, hot/cold inversion, setpoints, differentials, power steps, and operating time bands.

The DDC implements the Modbus RTU protocol as a slave device, in the following modes: 19.200 8N1; 19200 8E1; 19200 8N2; 9600 8N1; 9600 8E1; 9600 8N2.

The default modbus address is 1, and can be configured via the DDC's display which supports the following modbus function codes: (01) Read Coil Status; (02) Read Discrete Input; (03) Read Holding Register; (04) Read Input Register; (05) Write Single Coil; (06) Write Single Register; (15) Write Multiple Coil; (16) Write Multiple Register; (23) Read/Write Multiple Register.

The DDC is equipped to support broadcast messages.



Robur is dedicated to dynamic progression  
in research, development and promotion  
of safe, environmentally-friendly, energy-efficiency products,  
through the commitment and caring  
of its employees and partners.

## La Mission Robur



Robur Spa  
tecnologie avanzate  
per la climatizzazione  
Via Parigi 4/6  
24040 Verdellino/Zingonia (Bg) Italy  
T +39 035 888111 F +39 035 884165  
[www.robur.it](http://www.robur.it) [robur@robur.it](mailto:robur@robur.it)

