



SPD

Service Procedure Document

LCCII



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1 INTRODUCTION

The LCCII consists of:

- a primary circuit, which is connected to a hospital cooling water system or a chiller.
- a direct connection to the primary circuit for the cryo compressor
- two hydraulically separated secondary liquid cooling circuits; one for cooling the gradient coil and one for the gradient amplifier(s). Both secondary cooling loops are closed loop and pressurized to 1.5 to 2 Bar (stationary filling pressure of the hydraulic system).

The flow through the secondary loops is regulated at the secondary side. As a result there is a constant pressure drop over the primary connection, which benefits the performance of a connected chiller.

The cabinet is prepared for in-cabinet installation of a cryo compressor.

Next cryo compressors are used:

- the APD compressor type HC-8E (10K)
- the Sumitomo compressor type F-50, called SHI (4K)

From hereon the cryo compressors will be called APD or SHI compressors.

The LCCII is available in four different configurations:

- 50 Hz, with a step down transformer (400V / 480V ~ to 220V~) for the APD cryo compressor (10K).
- 60 Hz, with a step down transformer (400V / 480V ~ to 220V~) for the APD cryo compressor (10K).
- 50Hz for the SHI cryo compressor (4K).
- 60Hz for the SHI cryo compressor (4K).

The LCC-II has different pumps for the gradient coil loop (GC) and gradient amplifier loop as well as for 50Hz and 60Hz. (a total of 4 different pumps)

1.1 COMPATIBILITY

A complete LCCII cabinet is downwards compatible with an older LCC cabinet. However, when an older LCC is replaced by an LCCII cabinet the system software release must be R2.6.3 or higher.

Minimal hardware requirement: CDAS, Copley 281 / 281+, Copley 78X gradient amplifiers.

Minimal software requirement: R2.6.3 or higher

1.2 COOLANT SAFETY

1.2.1 Gradient coil circuit (GC)

The coolant for the gradient coil consists of distilled water with inhibitor and biocide as additives.

An inhibitor biocide packaging contains, a small bottle of inhibitor and a small bottle of biocide.

The bottle marked 'Inhibitor' contains 6 ml of inhibitor mixed with water to a volume of 30 ml. This will result in a concentration of 0.2 ml/l when added to the 30 liter distilled water of the gradient coil cooling circuit (further called GC).

The bottle marked 'Biocide' contains 2.7 ml of biocide mixed with water to a volume 30 ml. This will result in a concentration of 0.09 ml/l when added to the 30 liter distilled water of the GC circuit.

Please realize that the inhibitor and biocide are potentially harmful fluids; precautions must be taken when working with these fluids. Refer to Material Safety Data Sheets MSDS#9 'Inhibitor' and MSDS#10 'biocide' for detailed information including safety and disposal instructions.

NOTE

All types gradient coil use all, the same type of coolant.

1.2.2 Gradient amplifier circuit (GA)

With each LCC, 25 liter coolant will be supplied. The coolant consists of a mix of 50% Dowterm SR1 (inhibited ethylene glycol) and 50% water. The pink colored liquid has a glycol odor. There are no significant immediate hazards for emergency response known.

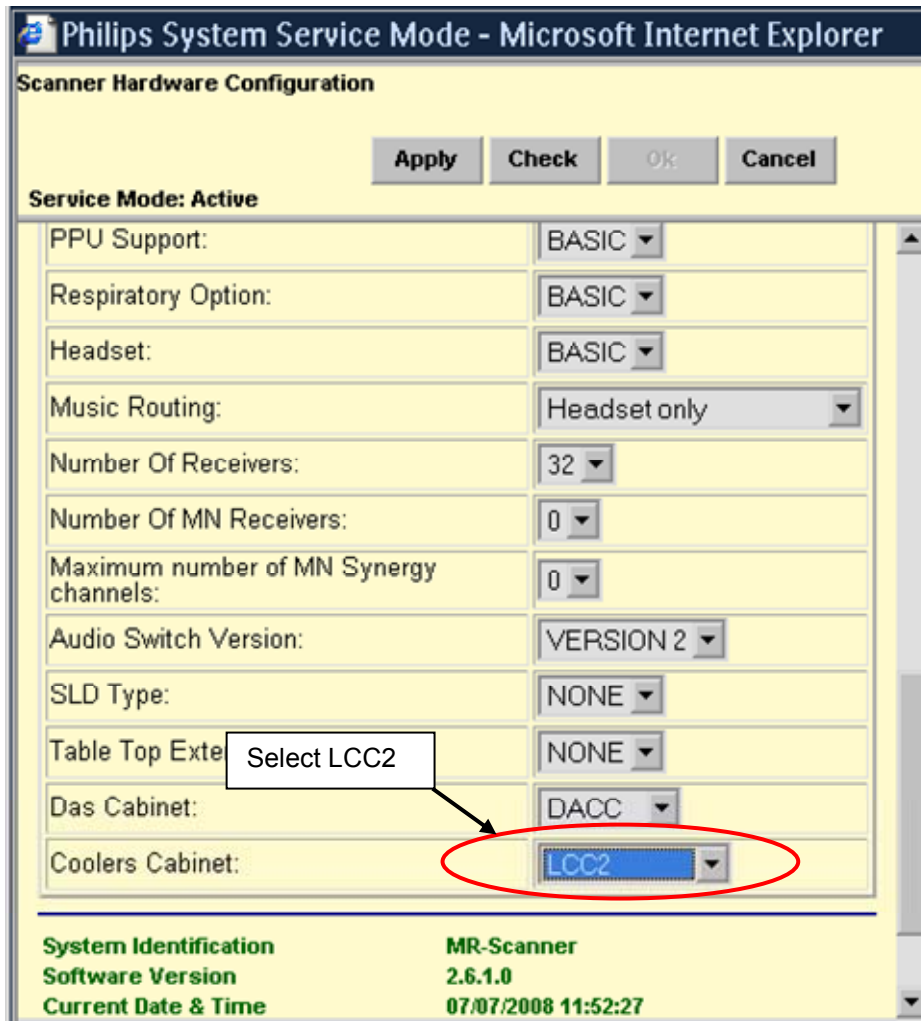
Refer to Material Safety Data Sheets MSDS MR-011 for detailed information including safety and disposal instructions.

2 PROGRAMMING

2.1 CONFIGURATION IN FSF

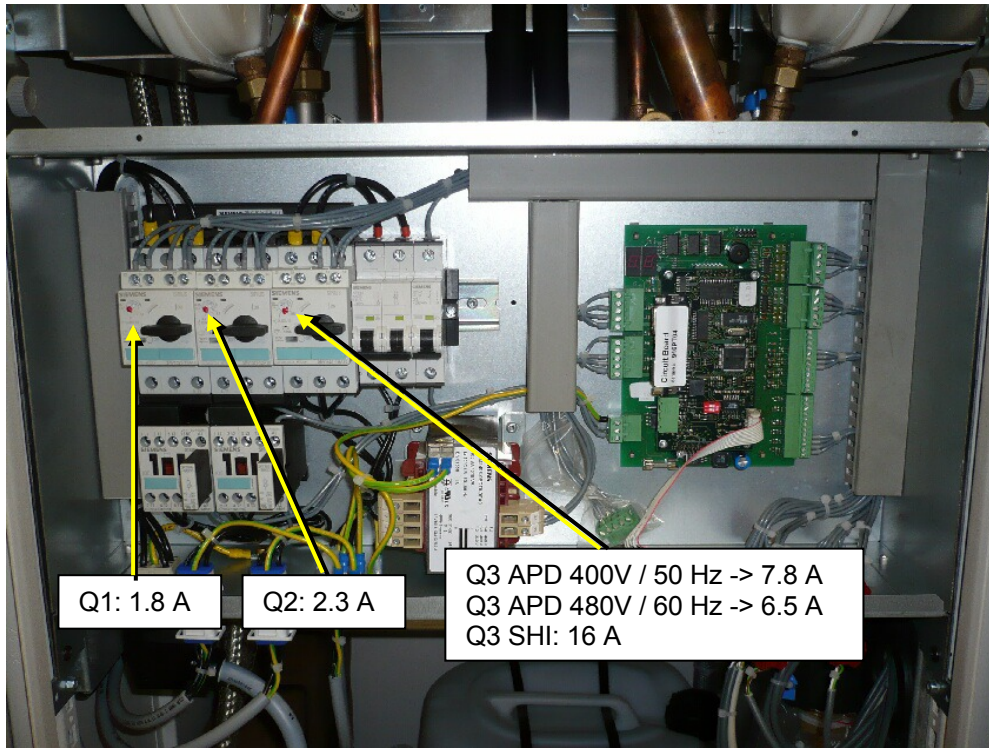
Configure the LCCII in FSF, if not already done.

Figure 1 – FSF scanner hardware configuration



2.2 Q1, Q2 AND Q3 CURRENT SETTING

Figure 2 – Current settings



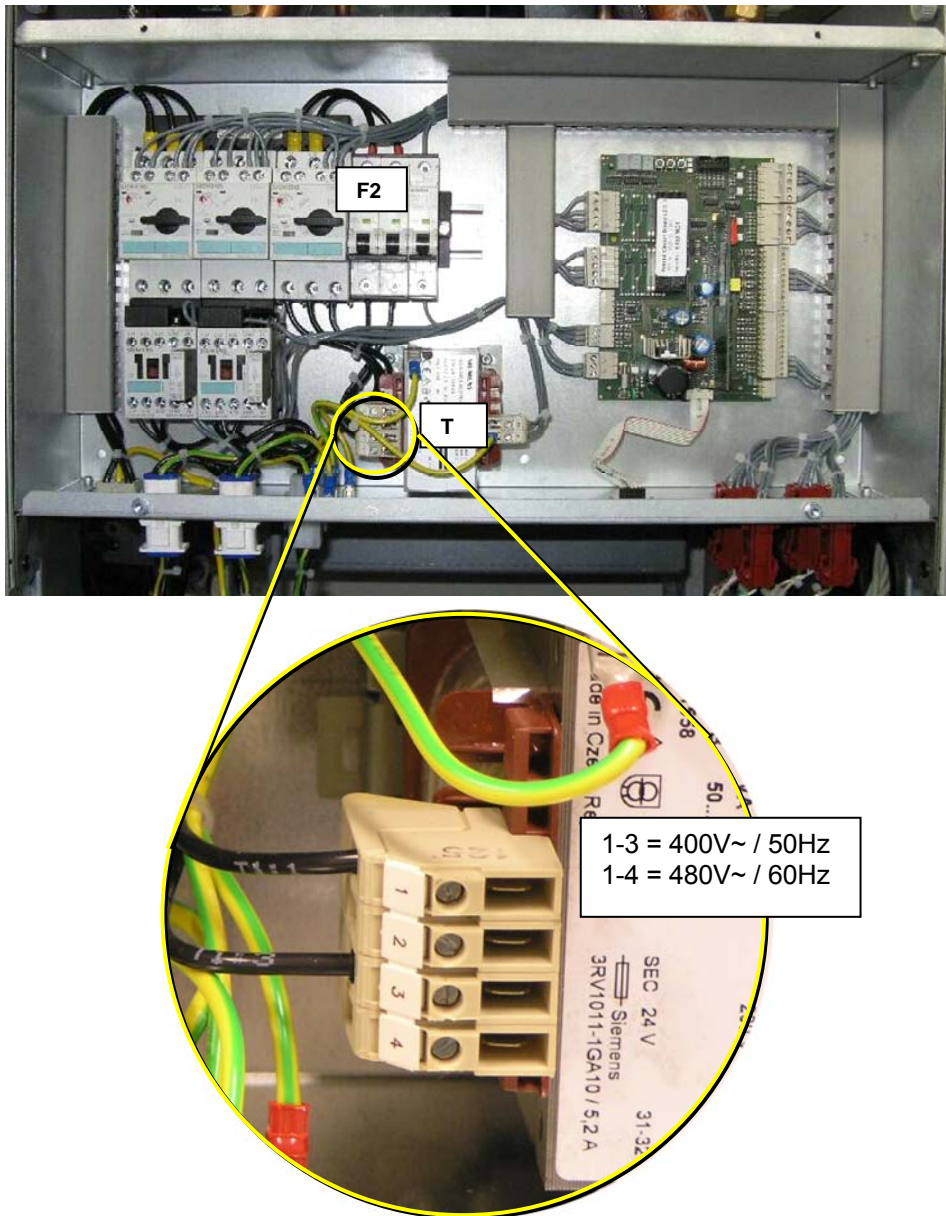
2.3 VOLTAGE PROGRAMMING LCCII

NOTE

Voltage programming is already done in the factory. However, for replacement electronic boxes, voltage programming must be checked / set for the correct voltage / frequency.

1. Ensure that F2 is switched OFF. (See Figure 3.)
2. Select the right voltage for the PCB power supply by connecting cable T1:3 between T1 (transformer) and F2 (circuit breaker primary) to the right voltage taps on the transformer. See Figure 3.

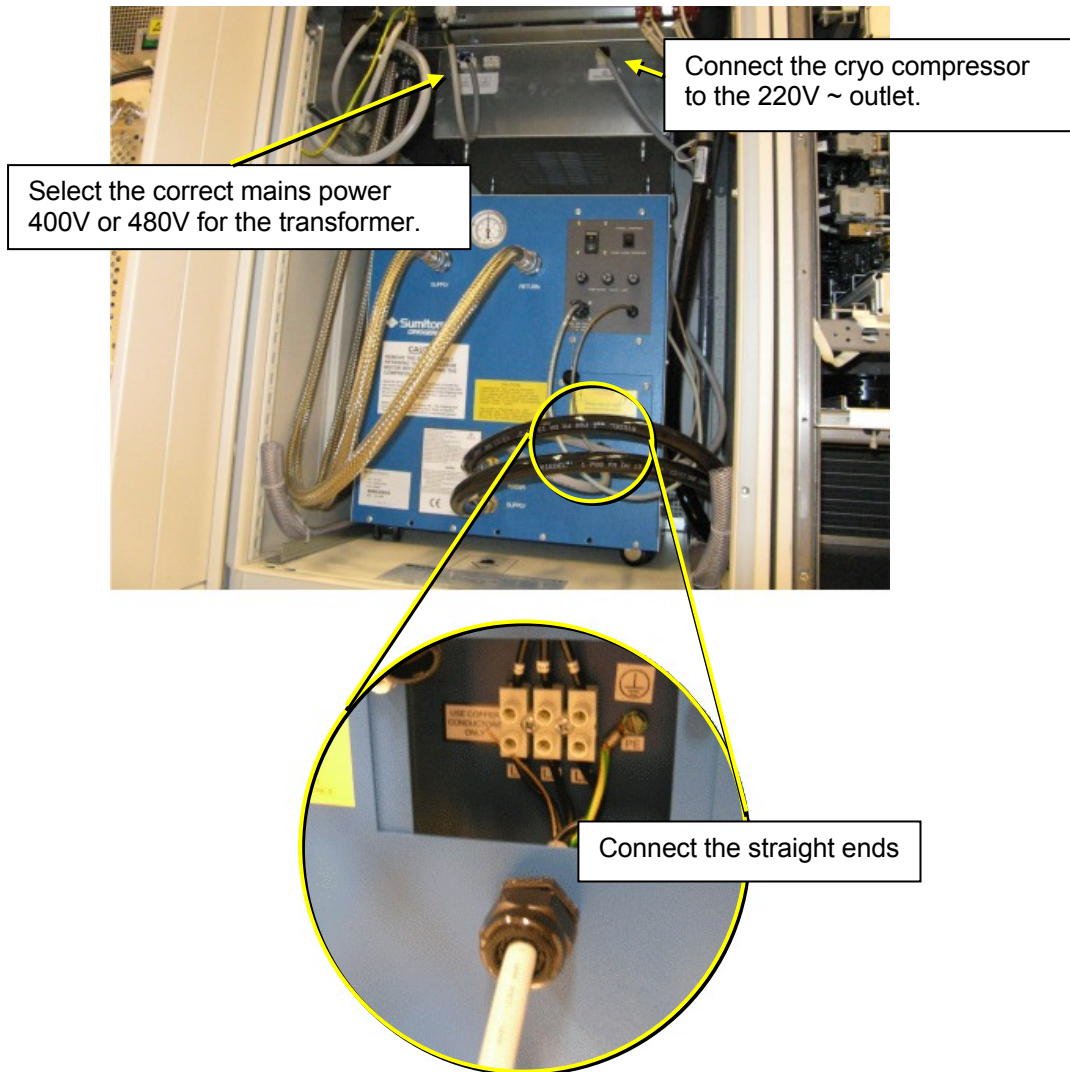
Figure 3 – Voltage programming for T1



2.4 VOLTAGE PROGRAMMING APD CRYO COMPRESSOR

A transformer is pre-installed to adapt of the mains supply in order to meet the power requirements for the APD Helium compressor. The transformer is powered via the electronics box. The transformer transforms the mains supply 400 V / 50 Hz or 480 V / 60 Hz for the helium compressor to 220 V / 50 Hz or 60 Hz. See Figure 4.

Figure 4 – Wiring the mains power for the APD compressor

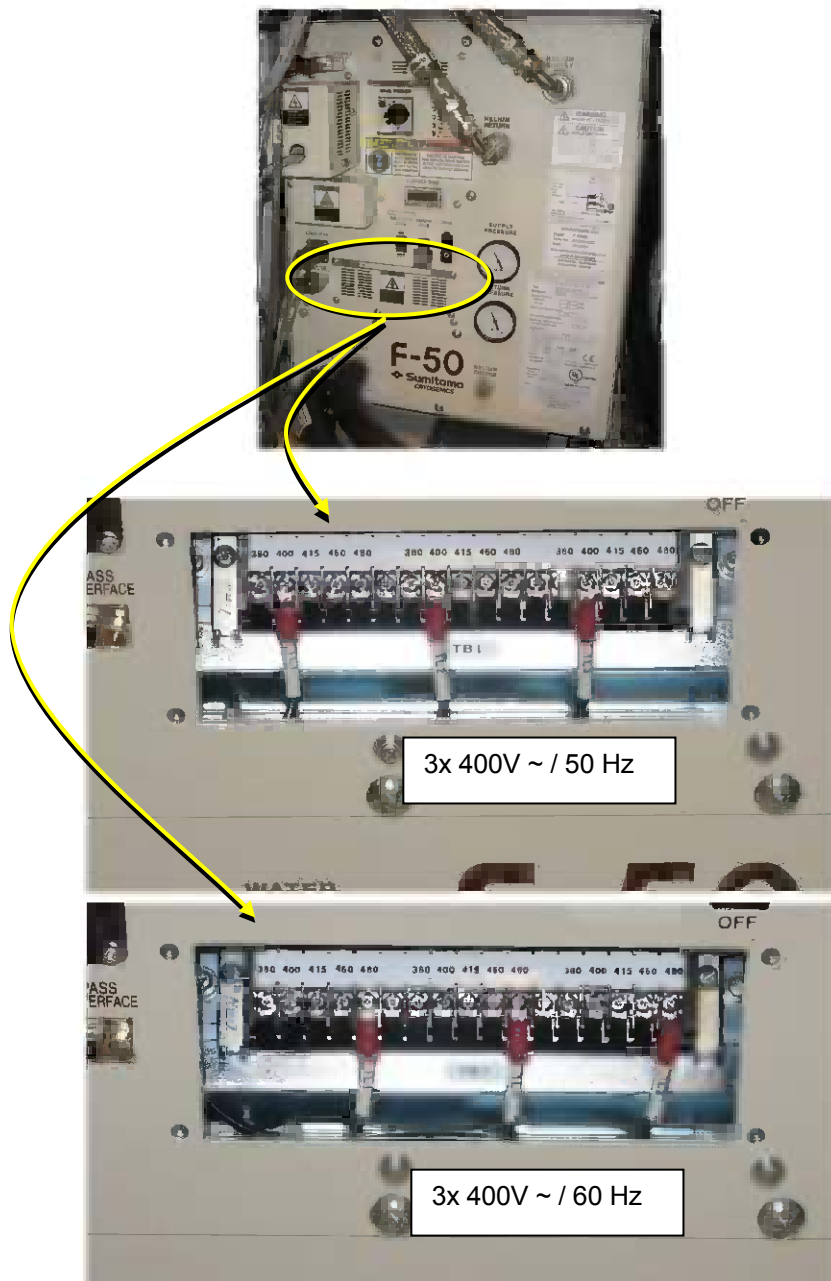


1. Use the supplied mains cable and connect the straight ends to the terminals inside the APD helium compressor before installing the unit inside the LCCII.
2. Select the correct mains power 400V or 480V for the transformer.
3. After installation of the compressor, plug in the other end of the mains cable to transformer 220V outlet.

2.5 VOLTAGE PROGRAMMING SHI CRYO COMPRESSOR

1. Use the supplied mains cable and connect the straight ends to the corresponding voltage terminal on the SHI cryo compressor before installing the unit inside the LCC. See Figure 5.
2. Connect the mains power connector directly to 1X3 at the bottom of the electronic box.

Figure 5 - Wiring the mains power for the SHI compressor







3 TEST PROCEDURES

3.1

3.2 PHASE ORDER MAINS CONNECTION PUMPS

Typical pressure and flow.

Precondition: the pressure vessels are pressurized to 1 bar prior to filling the LCC II.

Circuit	Phase rotation	Circuit pressure	Flow
		50 Hz and 60HZ	
GC loop (wrong)		~5 bar	Adjustable to 20 l/m
GC loop		~6.5 bar	Adjustable to 20 l/m
GA loop (wrong)		~4 bar	Adjustable to 2x 25l/m
GA loop		~6.3 bar	Adjustable to 2x 35l/m

Phase order: L1, L2, L3 (or U, V, W), right rotating phase direction for 50 Hz as well as for 60 Hz.

If all cabling is connected according to labeling and the hospital mains has right rotating phase direction, then the pumps should rotate in the correct direction. Measure at the output of the thermal pump switches Q1 and Q2 or relays K1 and K2 in the LCC II electronics box.

60 Hz Grundfos pumps run in the opposite direction of the 50 Hz Grundfos pumps. The correct direction of rotation for the pump motor is already factory configured, at the pump motor connection block.

As a result the measuring of phase rotation is identical for 50 Hz and 60 Hz.

To check the phase rotation, use a phase rotation indicator. Figure 6 shows such a phase rotation meter 4522 500 66301 (TC100), which is available in the tool catalogue at InCenter.

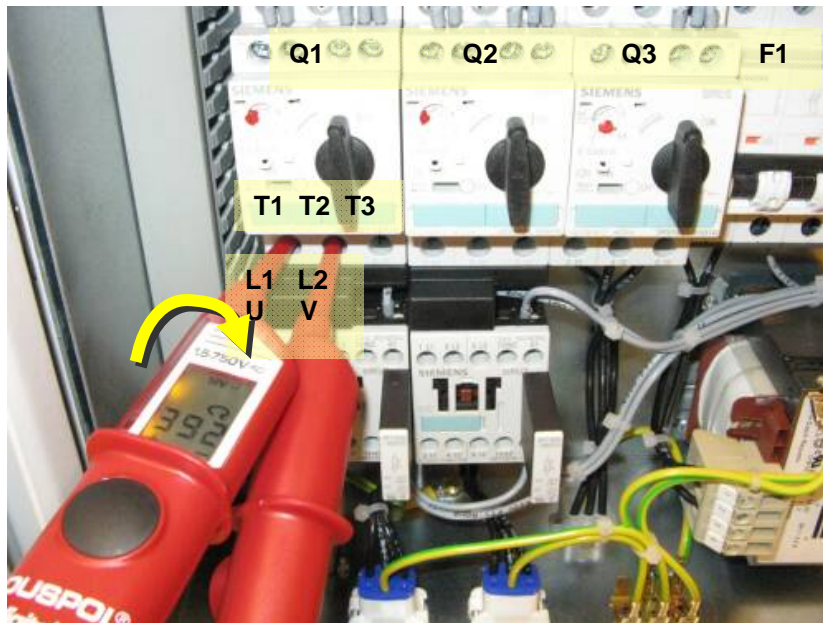
Figure 6 - Phase rotation indicator



Procedure:

1. Open the electronic box. The pumps are still running, or at least Q1 and Q2 is switched on.
2. Measure the phase rotation at the thermal switches of the pumps Q1 and Q2. Measure also the phase rotation at the thermal switch for the Cryo compressor F1. For the first two phases, measure tip L1 to T1 of the switch and L2 to T2. This measurement must show right rotation. See Figure 7.

Figure 7 – Measure in the electronic box



- For the second and third two phases, keep tip L2 to T2 of the switch and measure with tip L1 now to T3. This measurement must show left rotation, because the L2 tip is still at the second phase. See Figure 8. Phase rotation for all 3 phases is now right rotating for all three phases at the switch outputs.

Figure 8 – Measure in the electronic box



- If the phase rotation for all 3 phases at Q1, Q2 and Q3 is left rotating (wrong), swap two of the phase wires at LCC II mains power connection X3 inside the gMDU. If the Cryo compressor now runs in the wrong direction, swap also two of the phase wires at the Cryo compressor.
- Close the electronics box and install the LCC II front cover.

3.3 LCC BOARD TEST

This test shows the software version which is uploaded to the board and the serial number of the board.

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start → MR Applications → Service Applications (FSF)**
3. **Select: System adjustment → Test and Tuning Procedures**
4. Select: **Diagnostic procedures**
5. Select: **Gradient**
6. Select: **LCC**
7. Select: **LCC Info board test**
8. Select: <Proceed> After reading the instructions, to start the measurement.
9. An MRL is shown upon completion.
10. Select: <**Proceed**> to return the 'LCC' menu

3.4 LCC II INFO OVERVIEW TEST, TEMPERATURE/ PRESSURE CHECK

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: Start → MR Applications → Service Applications (FSF)
3. Select: System adjustment → Test and Tuning Procedures Select: Diagnostic procedures
4. Select: **Gradient**
5. Select: LCC
6. Select: LCC Info overview test
7. The test shows a list of results as shown in Figure 9.
8. Print out the LCC info overview test mrl, it can be used as reference upon failures in the future.
9. Verify, by feeling, that the outgoing water of the cryo compressor is warmer than the incoming water. This way the flow through the cryo compressor is right.

Figure 9 - LCC Info overview test

Overview of LCC parameters

Result: Error

Flag	Parameter Name	Actual Value	Nominal Value	Spec Value
	LCC: Board Access	Passed	Passed	Passed
	LCC: Software version/layout	0.22		
	LCC: Serial number	7		
	LCC: Primary Temperature T1 [D	13.1	10.0	[5.0 : 15.0]
***	LCC: Primary Flow [liter/min]	24	70	[40 : 150]
	LCC: GA Valve Position [Sec]	10.7	120.0	
	LCC: GA Temperature [DegC]	25.6	24.5	[18.0 : 32.0]
	LCC: GA Setpoint Temp [DegC]	25.0	25.0	[20.0 : 30.0]
	LCC: GA Valve Gain [%]	8.0	5.0	
	LCC: GA Valve Int Time [Sec]	30.0	30.0	
	LCC: GA Pump Status	ON	ON	ON
	LCC: GA Pump Operating hours	455.0		>0.0
	LCC: GA Filling Pressure [Bar]	2.3	1.2	[-3.0 : 9.9]
	LCC: GC Valve Position [Sec]	6.4	120.0	
	LCC: GC Temperature [DegC]	25.3	24.5	[18.0 : 32.0]
	LCC: GC Setpoint Temp [DegC]	25.0	25.0	[20.0 : 30.0]
	LCC: GC Valve Gain [%]	8.0	5.0	
	LCC: GC Valve Int Time [Sec]	50.0	50.0	
	LCC: GC Pump Status	ON	ON	ON
	LCC: GC Pump Operating hours	455.0		>0.0
	LCC: GC Filling Pressure [Bar]	2.2	1.2	[-3.0 : 9.9]

Cooling water inflow out of spec

This information is also displayed in the system log file upon LCCII failure. Just look for 'LCC' in the log file.

3.5 LCC COPY HW PARAMETERS TO LCC

Normally there is no reason to use this test. This test is only to be used when the LCC parameters must be updated. When this is needed, the field will be informed.

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start** → **MR Applications** → **Service Applications (FSF)**
3. **Select: System adjustment** → **Test and Tuning Procedures**
4. Select: Diagnostic procedures
5. Select: **Gradient**
6. Select: **LCC**
7. Select: **LCC Copy HW Parameters to LCC**
8. Select: <Proceed> After reading the instructions to start the measurement.
9. An MRL is shown upon completion.
10. Select: <Proceed> to return the 'LCC' menu

3.6 LCC RESET HOUR COUNTER GA PUMP

This procedure must be used when a pump is replaced.

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start → MR Applications → Service Applications (FSF)**
3. **Select: System adjustment → Test and Tuning Procedures**
4. Select: Diagnostic procedures
5. Select: **Gradient**
6. Select: **LCC**
7. Select: **LCC Reset the hour counter GA pump**
8. Select: <Proceed> After reading the instructions, to start the measurement.
9. An MRL is shown upon completion.
10. Select: **<Proceed>** to return the 'LCC' menu

3.7 LCC RESET HOUR COUNTER GC PUMP

This procedure must be used when a pump is replaced.

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start → MR Applications → Service Applications (FSF)**
3. **Select: System adjustment → Test and Tuning Procedures**
4. Select: Diagnostic procedures
5. Select: **Gradient**
6. Select: **LCC**
7. Select: **LCC Reset the hour counter GC pump**
8. Select: <Proceed> After reading the instructions, to start the measurement.
9. An MRL is shown upon completion.
10. Select: **<Proceed>** to return the 'LCC' menu

3.8 LCC SYSTEM STARTUP

With this test the LCC can be started, while in standby. When the LCC is started, also the gradient amplifier will start up. Notice that this test will not work when the LCCII is in startup mode (display shows 1 1).

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start → MR Applications → Service Applications (FSF)**
3. **Select: System adjustment → Test and Tuning Procedures**
4. Select: Diagnostic procedures
5. Select: **Gradient**
6. Select: **LCC**
7. Select: **LCC System startup**
8. Select: <Proceed> After reading the instructions, to start the measurement.
9. An MRL is shown upon completion.
10. Select: **<Proceed>** to return the 'LCC' menu

3.9 LCC SYSTEM STANDBY

With this test the LCC can be switched to standby, while running. When the LCC is in standby mode (display code: 4 4), the axis amplifiers of the gradient amplifier will be switched off as a result. Notice that this test will not work when the LCCII is in startup mode (display shows 1 1).

Procedure:

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start** → **MR Applications** → **Service Applications (FSF)**
3. **Select: System adjustment** → **Test and Tuning Procedures**
- 4.
5. Select: Diagnostic procedures
6. Select: **Gradient**
7. Select: **LCC**
8. Select: **LCC System standby**
9. Select: <Proceed> After reading the instructions, to start the measurement.
10. An MRL is shown upon completion.
11. Select: **<Proceed>** to return the 'LCC' menu

4 ADJUSTMENT PROCEDURES

4.1 CRYO COMPRESSOR FLOW (PRIMARY WATER)

The cryo compressor is connected directly to the primary water in the LCCII. The primary flow distribution between the compressor loop, GC loop and GA loop is defined by design of the primary plumbing system. There is no way to adjust the separate primary loops.

When the total primary flow of the LCC is within specification the flow through the compressor should be ok as well.

fault	cause	repair
Compressor switches off	Wrong flow direction	Swap supply and return compressor water hose.
Compressor switches off	Low flow	Check whether the ball valves are completely opened
Compressor switches off	Low flow	Check the primary main flow filter. When it was removed, the primary plumbing of the LCC can be contaminated with debris.

4.2 SECONDARY FLOW

1. Check / set the flow with the flow setters:

- The GC flow setter must read / be adjusted to 20 liter / minute.
- The GA I and GA II* flow setter must read / be adjusted to 35 liters / minute (the actual flow will be approximately 30 liters / minute, since the flow setter is calibrated for water).

Figure 10 - GC flow setter

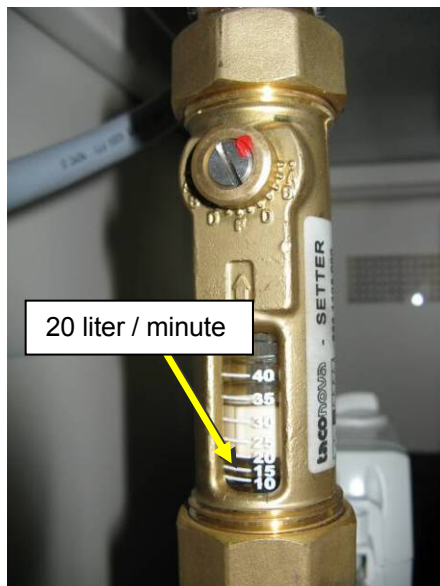
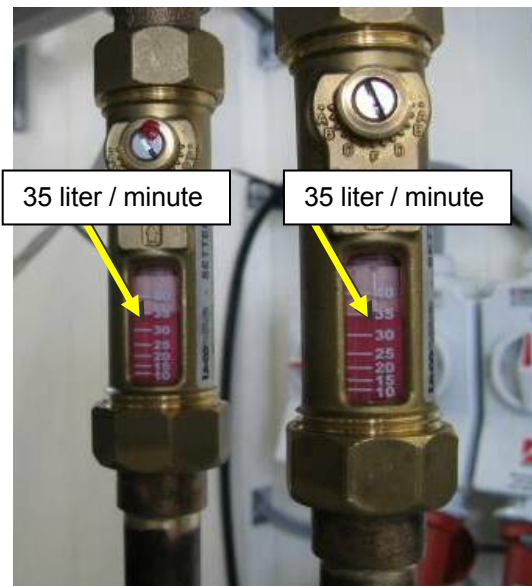
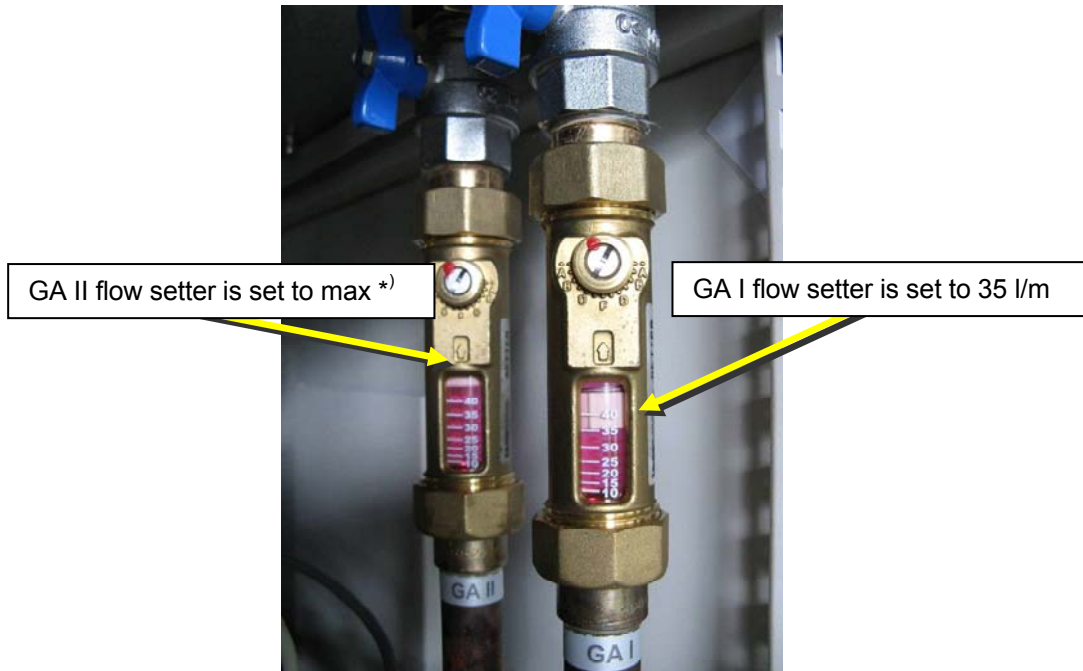


Figure 11 - GA flow setters



- *) If the by-pass is installed at GA II, the GA II flow setter must read / be adjusted to maximum (= 40) liters / minute. At 35 liters / minute the flow through the by-pass will be noisy.

Figure 12 - GA flow setters (GA 2 by-pass)



- Eventually the displays show at the LCC II printed circuit board shows 2 2 (normal control).

2. Both the GC and GA pressure gauges should measure approximately 6 bar, when the pumps are running.
3. Close the electronic box.
4. Close / install the LCC II front door / front panel.

5 REPLACEMENT PROCEDURES

5.1 PRIMARY CIRCUIT FILLING

1. Slowly open the primary circuit and check the system for leaks (i.e. all connections inside as well as outside the LCC II).
2. Open the ball valves to the helium compressor and check for leaks.
3. Refer to chapter 3.4 for checking the primary flow.

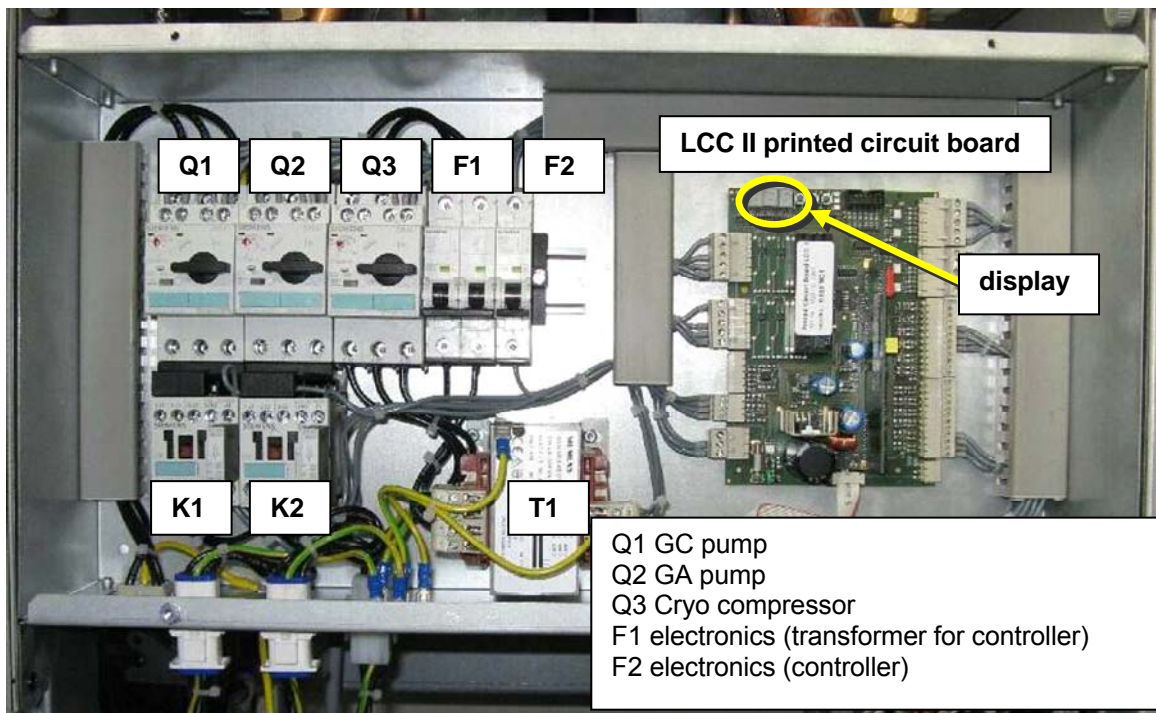
5.2 CONNECTING TO MAINS VOLTAGE SUPPLY

1. Check that all circuit breakers Q1 (gradient coil loop pump), Q2 (gradient amplifier loop pump), F1 and F2 (both for the electronics) are switched OFF (default factory setting). See Figure 13.
2. Switch on the LCC II mains power inside the gMDU cabinet, if not already done.
3. Q3 (cryo compressor) can be switched on if the cryo cooling system is operational.
4. When all connections are checked and OK, then switch ON the mains power.
5. Power ON circuit breaker F1 and F2 to activate the controller. See Figure 13.

CAUTION

Do NOT switch on Q1 and Q2, until the GC and GC circuit is filled!

Figure 13 - Overview of the switches



Note: All switches are shown in the OFF position

5.3 THE FILLING PUMP

For filling and pressurizing the secondary closed loops of the LCC II, one must use the electrical filling pump (Figure 14). The electrical filling pump is shipped with every LCC II cabinet. The filling pump needs **230 V ~ 50 Hz** or 60 Hz (one phase, neutral and protective ground). The 10 m power cord of the filling pump can be connected to the mains inlet unit of the DACC.

With every filling pump, 4 hoses are shipped:

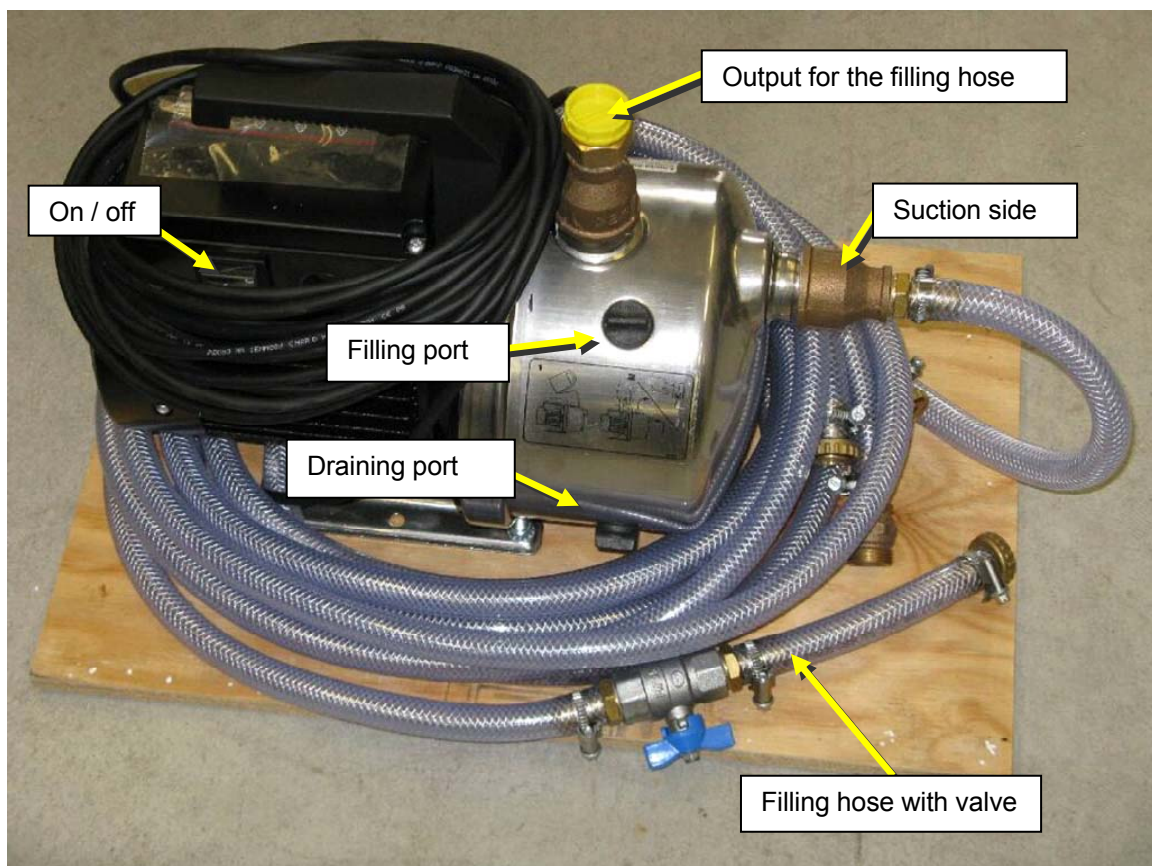
1. 1 suction hose (canister to pump suction)
2. 2 filling hoses with valve (filling pump pressure side to filling / drain port of the LCC II pump(s)). One hose for each loop.
3. 1 drain hose (LCC II back to canister)

After filling, the pump must be drained. After filling of the Dowtherm water mixture, it is mandatory to flush the remaining Dowtherm water mixture from the pump with fresh water.

When the filling pump is not cleaned after being used for Dowtherm, the pump will eventually damage during storage because of dried Dowtherm,

The filling pump must be stored in the technical room. It will be used for future planned maintenance and corrective maintenance.

Figure 14 - The electrical filling pump



5.4 PRESSURIZING THE EXPANSION VESSELS (AIR)

Required tools (as supplied with each LCCII):

- key ring air pressure gauge (not available as an FRU, it is actually a car accessory, replacements must be arranged local)
- hand air pump

NOTE

The expansion vessels must be pressurized prior to filling. If the coolant is already in the secondary loop, it needs to be drained prior to pressurizing the expansion vessel.

Each expansion vessel of LCC II has an 8 liter capacity (Figure 15). Because of air transport restrictions, the expansion vessels are not allowed to be pressurized during transport.

Figure 15 – The expansion vessels in LCC II

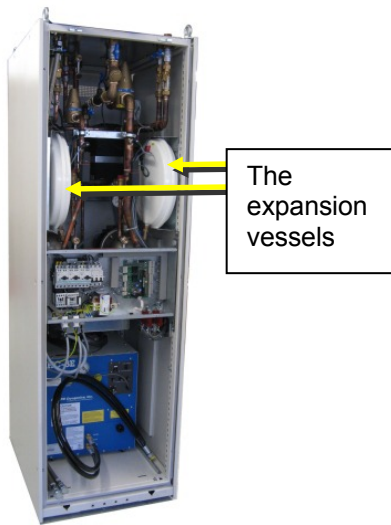


Figure 16 – Valve of expansion vessel



1. Open the blue valve below the expansion vessel (Figure 16).
2. Remove the cap of the air nipple of the expansion vessel.
3. Check the pressure. Notice that the display of the key ring air pressure gauge switches on only when it measures 0.4 bar or higher (Figure 18).
4. Pressurize the expansion vessel with the help of the hand air pump to 1 bar (Figure 17). This takes about 70 pump strokes. Check the pressure with the key ring air pressure gauge. The expansion vessel must be pressurized to 1 bar (0.9 – 1.1 bar).
5. Mount the air nipple cap.
6. Perform the steps above also for the other expansion vessel.

Figure 17 - Hand air pump on expansion vessel

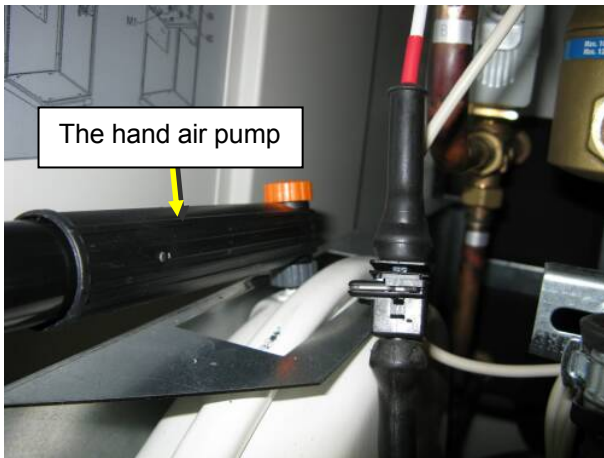


Figure 18 - Air pressure gauge



5.5 GC CIRCUIT FILLING / REPLACING THE WATER

Preconditions:

1. The expansion vessel must have been pressurized to 1 bar air pressure, prior to the LCC II filling. Refer to chapter 5.4.
2. It is advised to remove the filling pump from its packaging board.

CAUTION

The biocide and inhibitor has to be added to the canister with distilled water, prior to the filling / flushing. Since the circuits are pressurized closed loops, there is no possibility to add additives into the loops in another way.

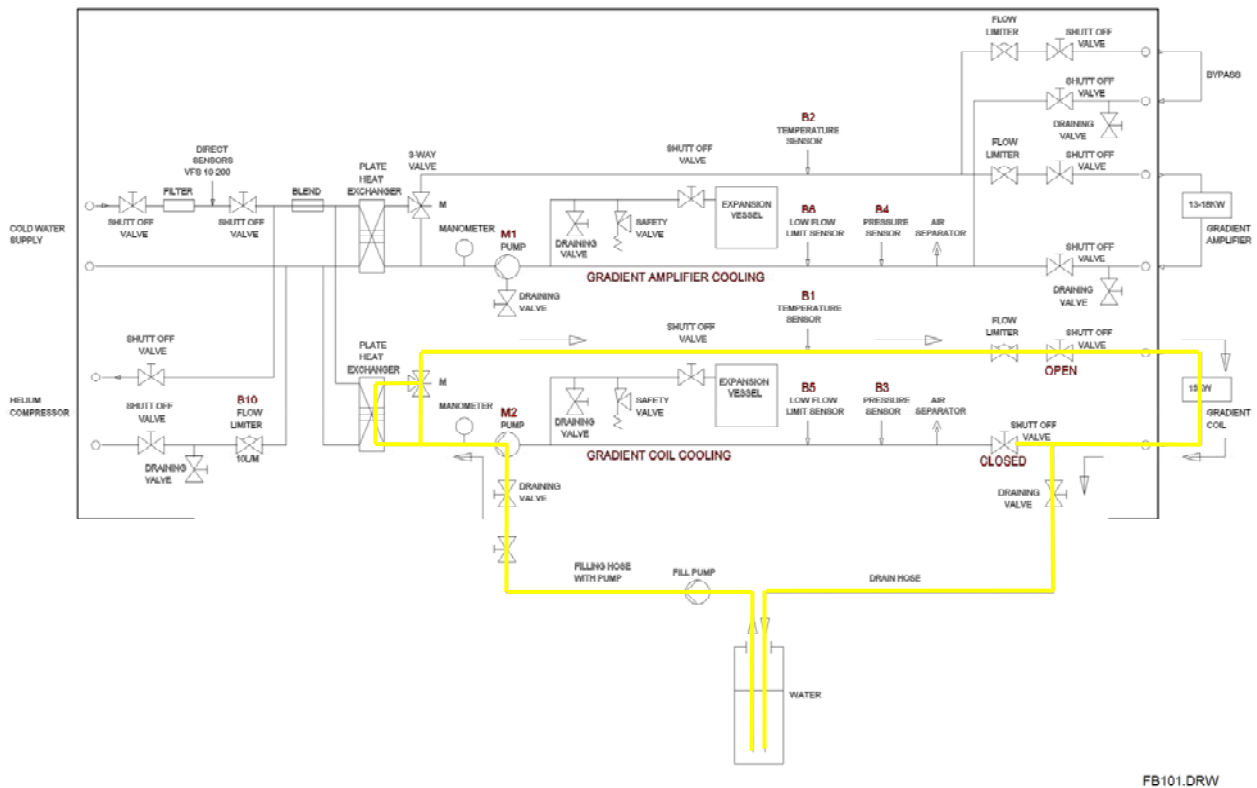
Figure 19 - GC filling setup



Figure 20 - GC replacing setup



Figure 21 - GC filling schematic



5.5.1 Setup

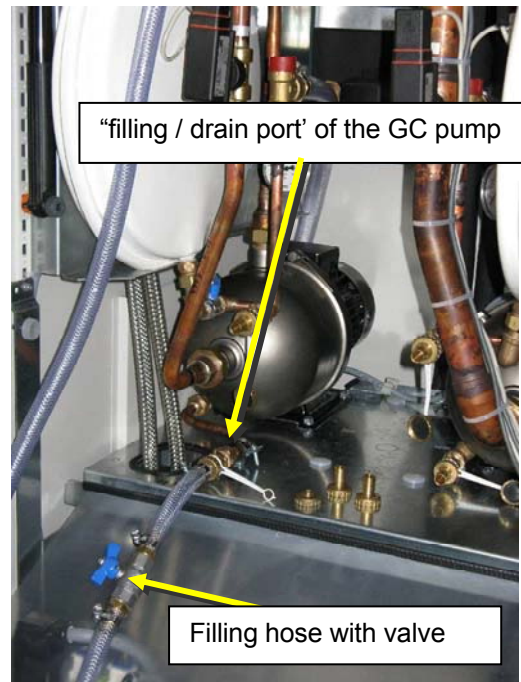
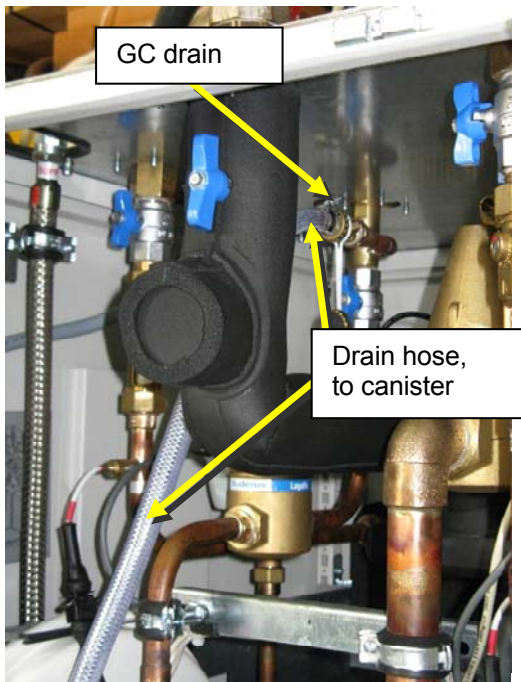
1. Open the LCC II front door / front panel.
2. Open the electronic box, at this stage the thermal switch for the GC pump is still switched off.
3. Loosen the electronic box and tilt it forward, to gain access the pumps.
4. Unroll the plastic splash guard sheet, to cover the electronic box.
5. Position the filling pump in front of the LCC II (Figure 19).
6. Ensure that the filling pump is powered off.
7. Connect the filling pump to a 230 V socket in the mains inlet unit in the data acquisition cabinet.
8. Put the suction hose (permanently connected to the filling pump) in the canister with distilled water.
9. Open the filling port of the filling pump (Figure 22) and fill the filling pump with approximately 2.5 liter distilled water. (The filling pump is not self priming!).
10. Close the filling port.
11. Open the canister with distilled water and add the inhibitor and biocide to the distilled water. Note that after filling the GC circuit, it is impossible to add the inhibitor and biocide.
12. Put the supplied gasket in the pump output fitting and connect the filling hose to the output of the filling pump. The valve at the output of the filling hose is still closed.
13. Connect the other end (valve side) of the filling hose to the 'filling / drain port' of the GC pump (Figure 24).
14. Connect a drain hose to the top GC drain port.
15. When filling put the other end of the drain hose in the canister with distilled water (Figure 23).
16. When replacing the water, put the other end of the drain hose in a empty canister.

Figure 22 - Priming the filling pump



Figure 23 - GC drain port

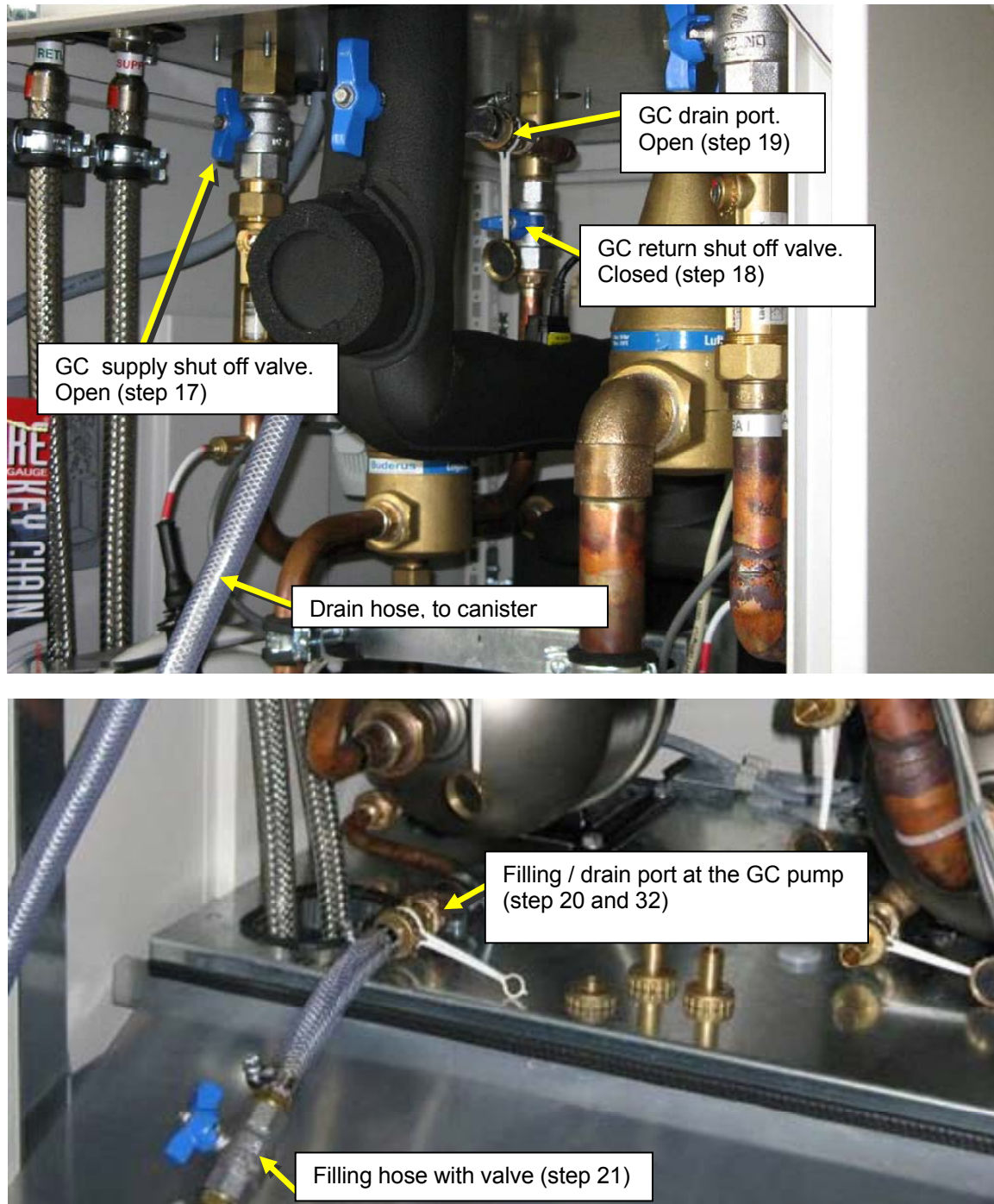
Figure 24 - GC filling / drain port



5.5.2 Setting the valves

17. Open the GC supply shut off valve at the top in the LCC cabinet. **If this valve accidentally remains closed during the filling, the filling pump pressure will exceed 3 bar, which will open the safety valve.** See Figure 25.
18. Close the GC return shut off valve (underneath the drain port).
19. Open the 'drain port' underneath the GC return input connection at the top of the LCC II.
20. Open the 'filling / drain port' at the GC pump.

Figure 25 - Setting the valves for GC



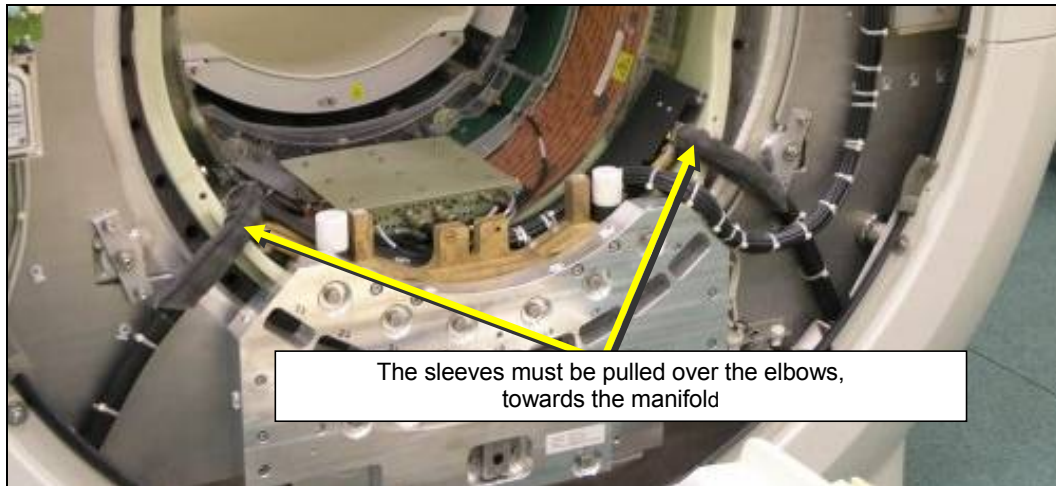
5.5.3 Filling / replacing the water

21. Open the valve in the filling hose.
22. Power on the filling pump.
23. When replacing the water: put the drain hose into fresh water tank as soon as the empty canister is filled.
24. Watch the drain hose, which goes back to the canister with distilled water.
25. As soon as the water becomes visible in the drain hose and the water becomes clear, which means there is no air anymore: **Close the valve in the filling hose and power off the filling pump.**
26. Close the 'drain port' underneath the GC return input connection at the top of the LCC II.

5.5.4 Inspection

27. Inspect all hose connections for leakages.
28. Pull the sleeves of the GC hoses over the hose elbow fittings (Figure 26).

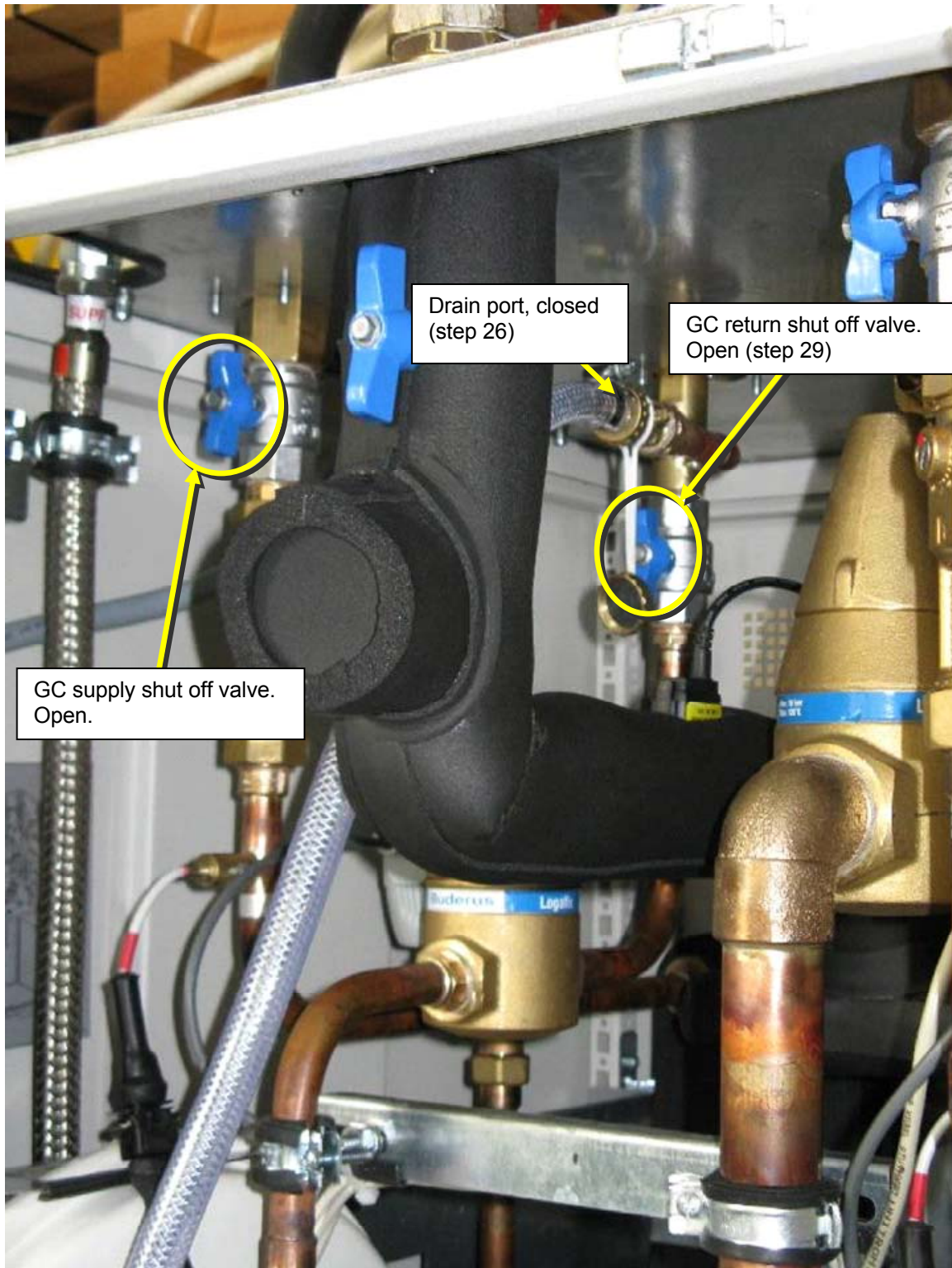
Figure 26 – Sleeves pulled over the elbows



5.5.5 Pressurizing and closing the loop

29. Open the GC return shut off valve (underneath the drain port), see Figure 27.
30. Power on the filling pump and open the valve in the filling hose.
31. When the pressure gauge shows between **2 – 2.5 bar**, close the valve in the filling hose and power off the filling pump. If the pressure is too high, open the valve in the filling hose to remove the overpressure.
32. Close the 'filling / drain port' at the GC pump.
33. Eventually, when remaining air is vented from the loop, the GC pressure gauge should measure **1.8 – 2.1 bar**, while the pumps are not running. Notice that the air pressure in the expansion vessel is identical to the circuit pressure now.

Figure 27 - Shut off valves



5.5.6 Draining the filling pump

34. Open the valve in the filling hose to release the pressure from the hose.

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35. Disconnect the filling hose from the GC pump 'filling / drain port' and put the end in the distilled water container.
36. Pull the suction hose from the canister with distilled water.
37. Operate the filling pump shortly to eject the water from the pump and hose.
38. Open the lower drain port of the filling pump and drain the remaining 2.5 liter water from the pump.

5.5.7 How to continue

39. If the GA loop is not yet filled, continue with GA circuit filling.
40. If both loops are filled, continue with Switching on the LCC II pumps chapter 5.7.

5.6 GA CIRCUIT FILLING

In the GA circuit there are two loops:

- GA I for one gradient amplifier or one gradient amplifier halve (depending on system configuration).
- GA II for a by-pass, second gradient amplifier or the other gradient amplifier halve (depending on system configuration).

For one gradient amplifier configurations: connect the gradient amplifier to GA I and connect the by-pass to GA II.

Notice that the Dowtherm water mixture can flow only in one direction. The backwards flow will be blocked by the flow setters in the secondary loop.

Preconditions:

The expansion vessel must be pressurized (1 bar air pressure) prior to the LCC II filling. Refer to the expansion vessel replacement procedure.

Figure 28 - GA filling setup



5.6.1 Setup

41. Open the LCC II front door / front panel.
42. Open the electronic box, at this stage the thermal switch for the GA pump is still switched off.
43. Loosen the electronic box and tilt it forward, to gain access the pumps.
44. Unroll the sheet plastic splash guard, to cover the electronic box.
45. Position the filling pump in front of the LCC II. Ensure that the filling pump is removed from its packaging board.

46. Ensure that the filling pump is powered off.
47. Connect the filling pump to a 230 V socket in the mains inlet unit in the data acquisition cabinet.
48. Open the new canister with the Dowtherm water mixture.
49. Put the suction hose (permanently connected to the filling pump) in the canister with the Dowtherm water mixture.
50. Put the supplied gasket in the pump output fitting and connect the filling hose to the output of the filling pump. The valve at the output of the filling hose is still closed.
51. Connect the other end (valve side) of the filling hose to the 'filling / drain port' of the GA pump.
52. Connect a drain hose to the top GA I drain port and put the other end in the canister with the Dowtherm water mixture. See Figure 30.

Figure 29 - 'Filling / drain port' of the GA pump

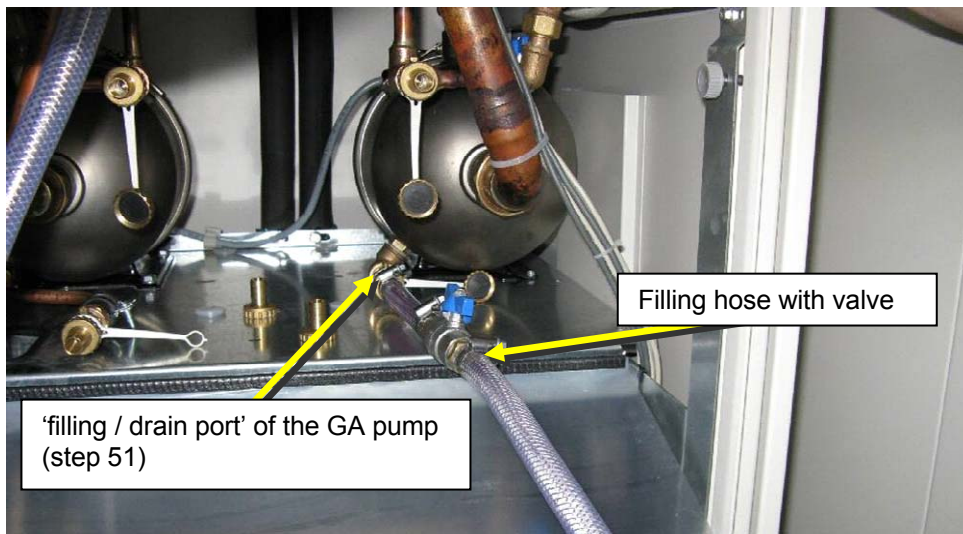
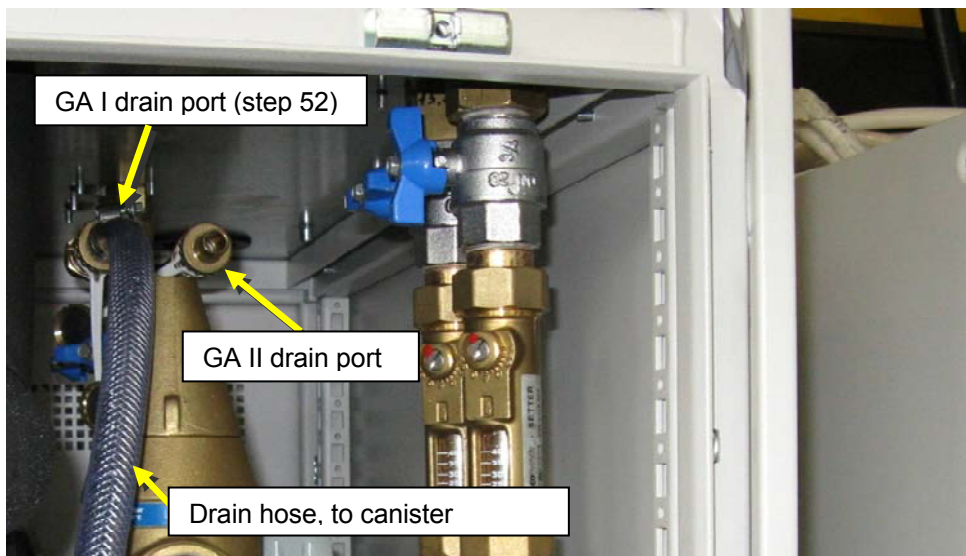


Figure 30 - GA drain ports



5.6.2 Priming the filling pump

53. Open the filling port of the filling pump and fill the filling pump with approximately 2.5 liter of Dowtherm water mixture. (The filling pump is not self priming!)
54. Close the filling port.

Figure 31 - Priming the filling pump



5.6.3 Setting the valves for GA I

55. Open the GA I supply shut off valve at the top in the LCC cabinet (GA II supply shut off valve at the top remains closed). **If this valve accidentally remains closed during the filling, the filling pump pressure will exceed 3 bar, which will open the safety valve.** See Figure 32.
56. Close the GA I and GA II return shut off valves.
57. Open the GA I 'drain port' underneath the GA I return input connection at the top of the LCC II.
58. Open the 'filling / drain port' at the GA pump. See Figure 33

Figure 32 - Setting the valves for GA I

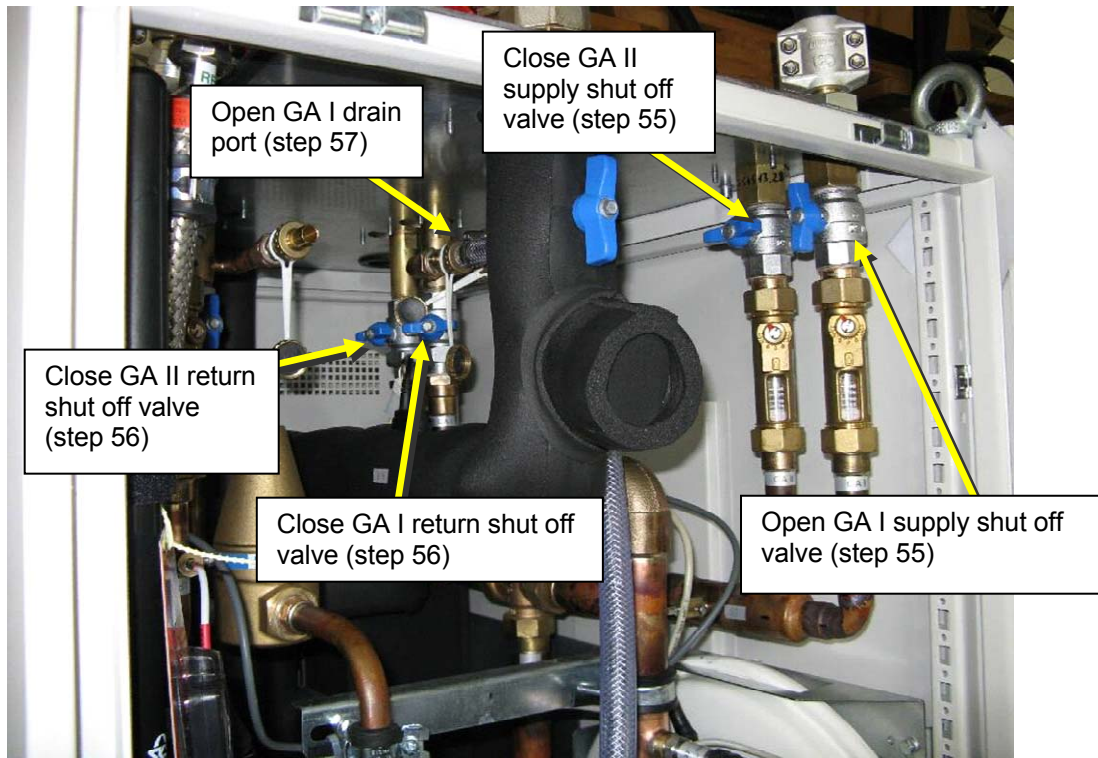
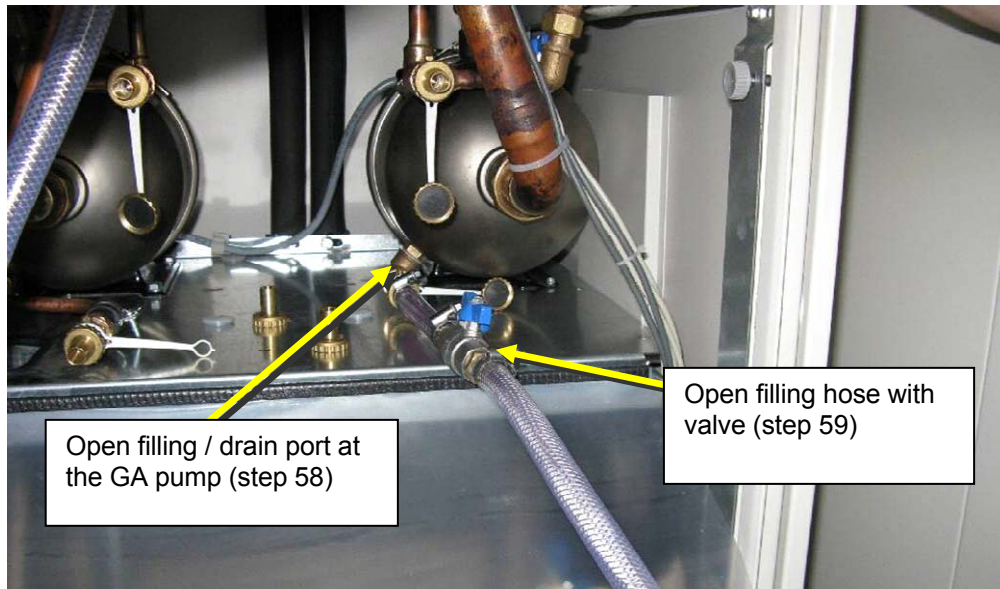


Figure 33 - The GA pump



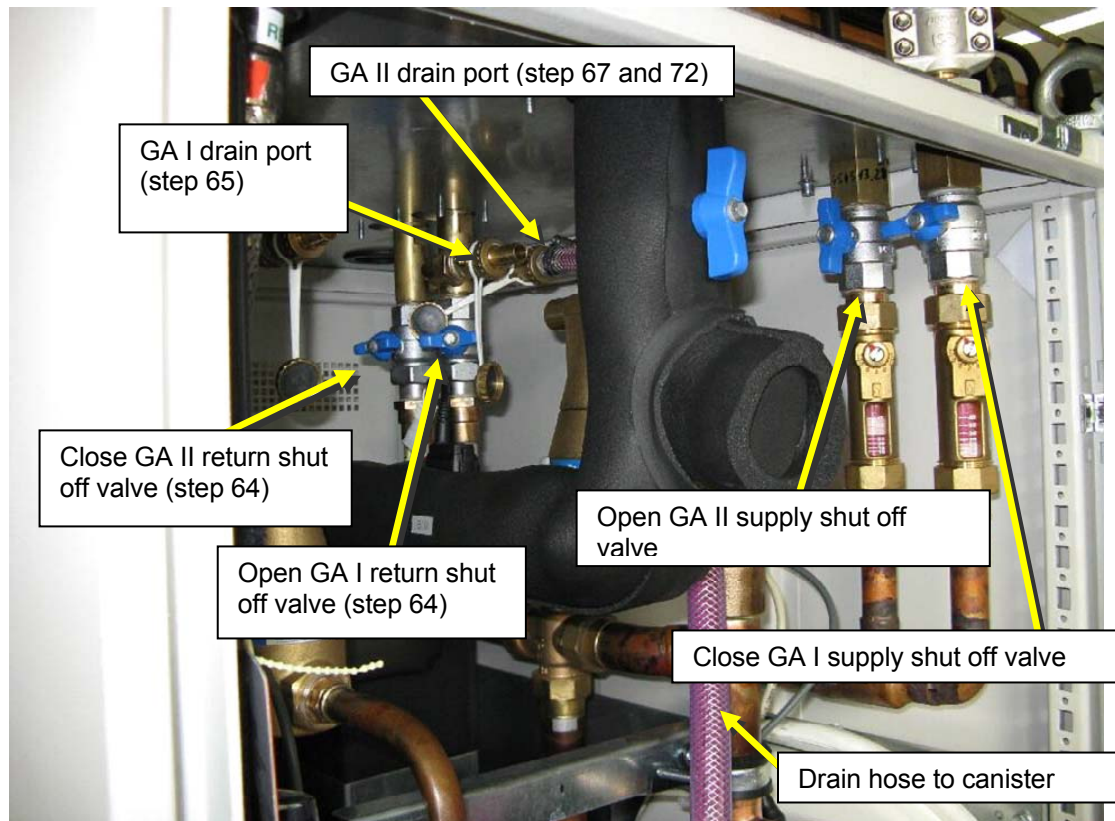
5.6.4 Filling GA I

- 59. Open the valve in the filling hose.
- 60. Power on the filling pump.
- 61. Look at the drain hose, which goes back to the canister with the Dowtherm water mixture.
- 62. As soon as the water becomes visible in the hose and the water becomes clear (which means there is no air in it), **close the valve in the filling hose and power off the filling pump.**

5.6.5 Setting the valves for GA II

63. Close GA I supply shut off valve and open the GA II supply shut off valve at the top in the LCC cabinet. **If this valve accidentally remains closed during the filling, the filling pump pressure will exceed 3 bar, which will open the safety valve.**
64. The GA I and GA II return shut off valves (underneath the drain ports) remain closed.
65. Close the drain port underneath the GA I return input connection at the top of the LCC II.
66. Move the drain hose to the GA II drain port.
67. Open the 'drain port' underneath the GA II return input connection at the top of the LCC II.

Figure 34 - Setting the valves for GA II



5.6.6 Filling GA II (perform also for C781 configurations)

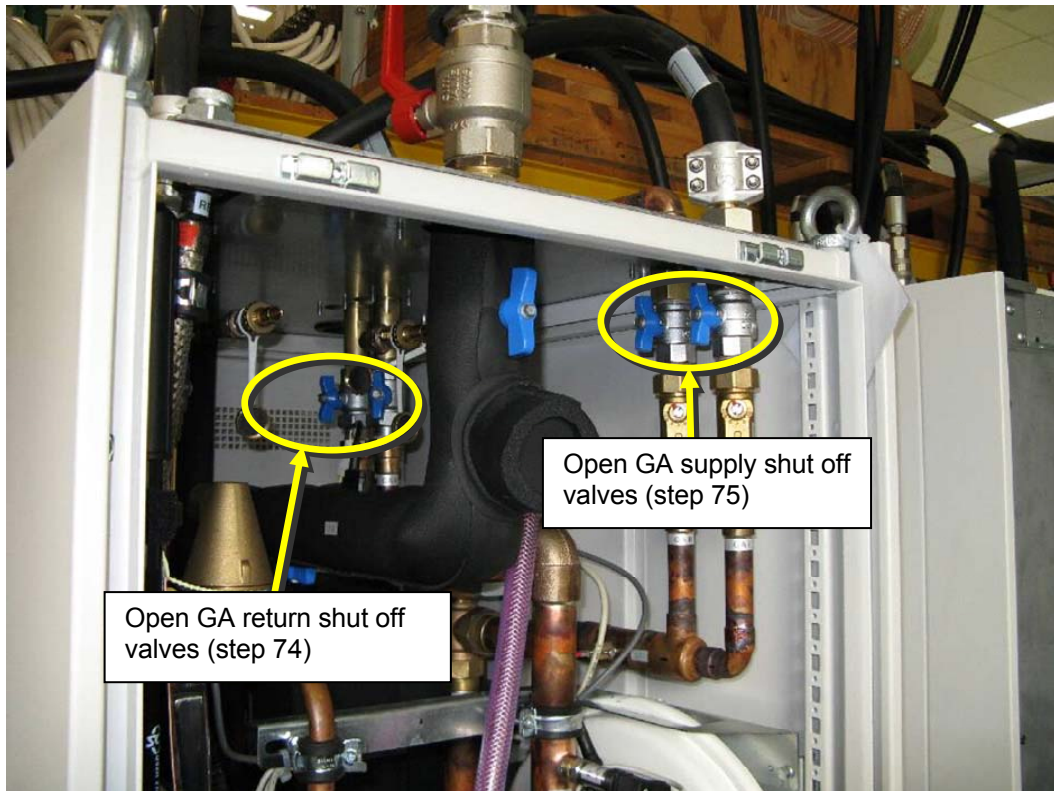
Because of the by-pass, this procedure must be done for the C781 configurations as well.

68. Open the valve in the filling hose.
69. Power on the filling pump.
70. Look at the drain hose, which goes back to the canister with the Dowtherm water mixture.
71. As soon as the Dowtherm water mixture becomes visible in the hose and it becomes clear (which means there is no air in it): **close the valve in the filling hose and switch off the filling pump.**
72. Close the GA 2 drain port underneath the GA 2 return input connection at the top of the LCC II.

5.6.7 Pressurizing and closing the loop

73. Disconnect the GA drain hose from the GA 2 drain port.
74. Open the GA 1 supply shut off valve (both supply shut off valves are opened now).
75. Open the GA 1 and GA 2 return shut off valves. See Figure 35.

Figure 35 - GA shut off valves



- 76. Pressurize the GA loop: look at the GA pressure gauge (right side), open the valve in the filling hose and power on the filling pump.
- 77. When the pressure gauge shows between **2 – 2.5 bar**: close the valve in the filling hose and power off the filling pump.
- 78. Close the 'filling / drain port' at the GA pump.
- 79. Eventually, when remaining air is vented from the loop, the GA pressure gauge should measure **1.8 – 2.1 bar**, while the pumps are not yet running. Notice that the air pressure in the expansion vessel is identical to the circuit pressure now.

5.6.8 Draining the filling pump

- 80. Open the valve in the filling hose to release the pressure from the hose.
- 81. Disconnect the filling hose from the GC pump 'filling / drain port' and put the end in the distilled water container.
- 82. Pull the suction hose form the Dowtherm water mixture canister.
- 83. Operate the filling pump shortly to eject the Dowtherm water mixture from the pump and hose.
- 84. Open the lower drain port of the filling pump and drain the remaining 2.5 liter Dowtherm water mixture from the pump.

5.6.9 Cleaning the filling pump

85. Clean the filling pump before stowing it away!
86. Open the fill port and fill it with clean water.
87. Put the end of the filling hose and suction hose in a canister filled with a couple of liter clean water. See Figure 36.

Figure 36 - Cleaning the filling pump



88. Power on the pump and let it run to flush out the remaining Dowtherm water mixture from it.
89. Drain 2.5 liter of water the pump, by opening the lower drain port. Close it afterwards.
90. The water with Dowtherm water mixture must be disposed according local regulations for chemical waste.

Notice that the filling pump will be damaged during storage because of dried Dowtherm, when it is not cleaned after use.

The filling pump must be stored in the technical room. It will be used for future planned maintenance and corrective maintenance.

5.6.10 How to continue

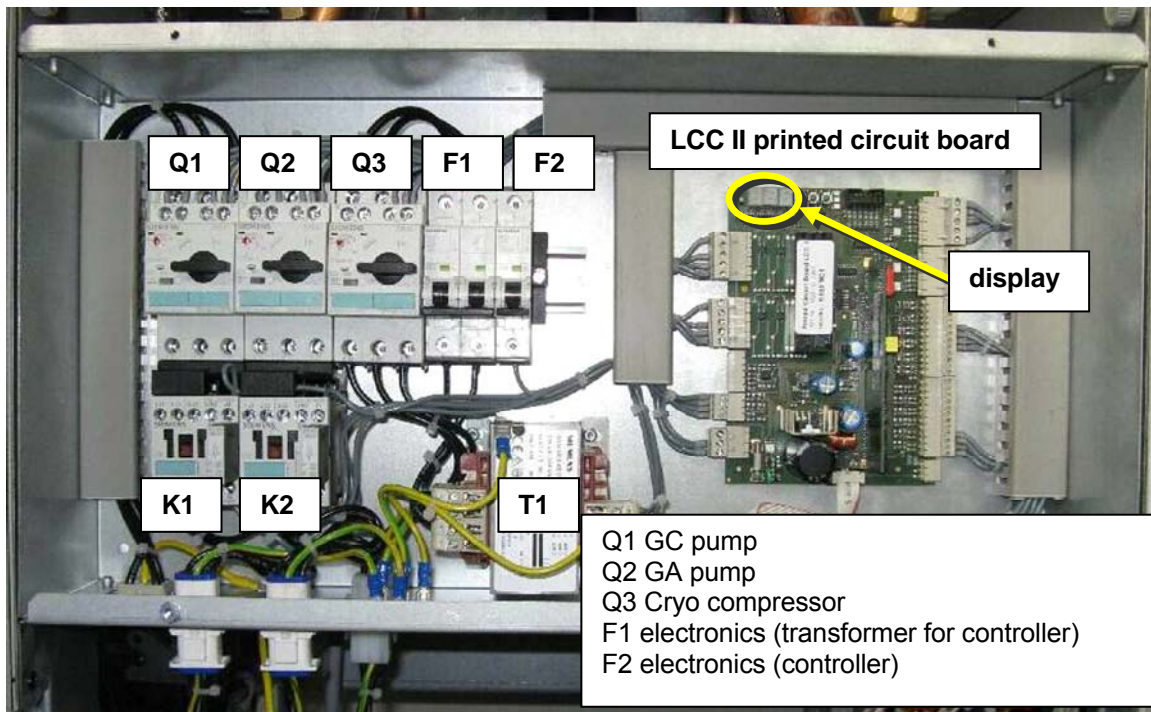
91. If the GC loop is not yet filled, continue with GC circuit filling.
92. If both loops are filled, continue with 'switching on the LCC II'.

5.7 SWITCHING ON THE LCC II PUMPS

Precondition: The secondary circuits GC and GA must be filled with coolant.

1. Open the LCC II front door / front panel (if not already done).
2. Open the electronic box, at this stage the thermal switches for the GC (Q1) and GA pump (Q2) are still switched off.
3. Switch on Q1, Q2, F1 and F2 (if F1 and F2 were already on, switch them off and on to reset the LCC II printed circuit board.)
4. The displays at the LCC II printed circuit board will first show 1 1 (initializing). The GC and GA circuit will operate independently. If both circuits are started at the same time, GA will be delayed with 1 to 2 seconds. The initialization phase will take 145 s (50 Hz), 175 s (60 Hz).
5. When the display shows 5 5 (start up flow), the pumps will start.
6. Eventually the displays show 2 2 (normal control).

Figure 37 - The electronic box



Note: All switches are shown in the OFF position

- 7. When the pumps start, check / set the flow with the flow setters:
 - The GC flow setter must read / be adjusted to 20 liter / minute.
 - The GA I and GA II* flow setter must read / be adjusted to 35 liters / minute (the actual flow will be approximately 30 liters / minute, since the flow setter is calibrated for water).

Figure 38 - GC flow setter

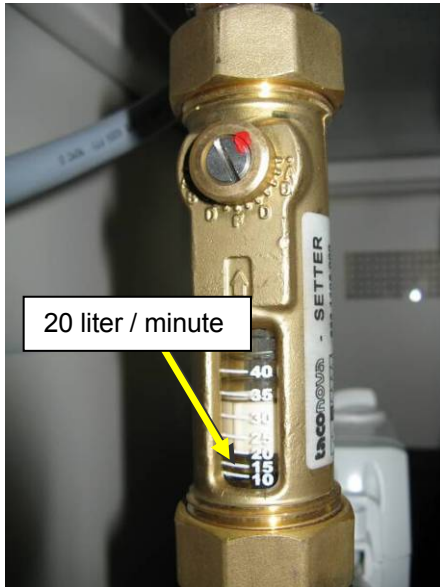
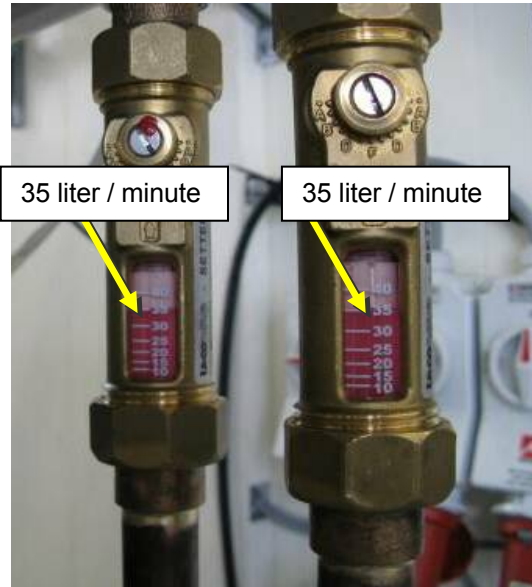
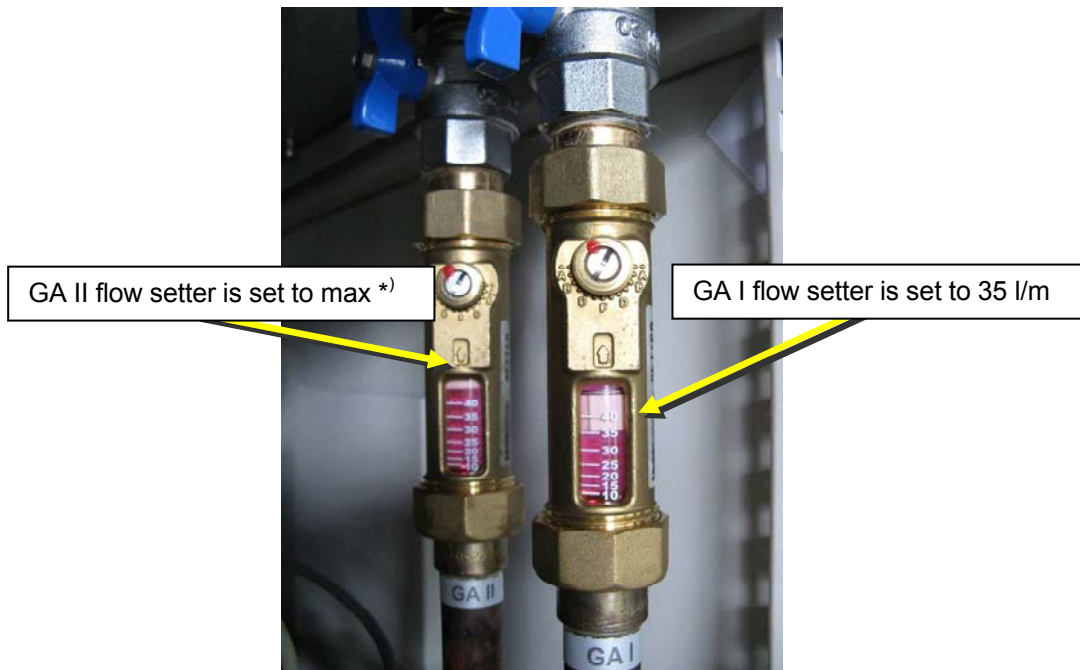


Figure 39 - GA flow setters



- *) If the by-pass is installed at GA II, the GA II flow setter must read / be adjusted to maximum (= 40) liters / minute. At 35 liters / minute the flow through the by-pass will be noisy.

Figure 40 - GA flow setters (GA 2 by-pass)



- Eventually the displays show at the LCC II printed circuit board shows 2 2 (normal control).

8. Both the GC and GA pressure gauges should measure approximately 6 bar, when the pumps are running.
9. Close the electronic box.
10. Close / install the LCC II front door / front panel.

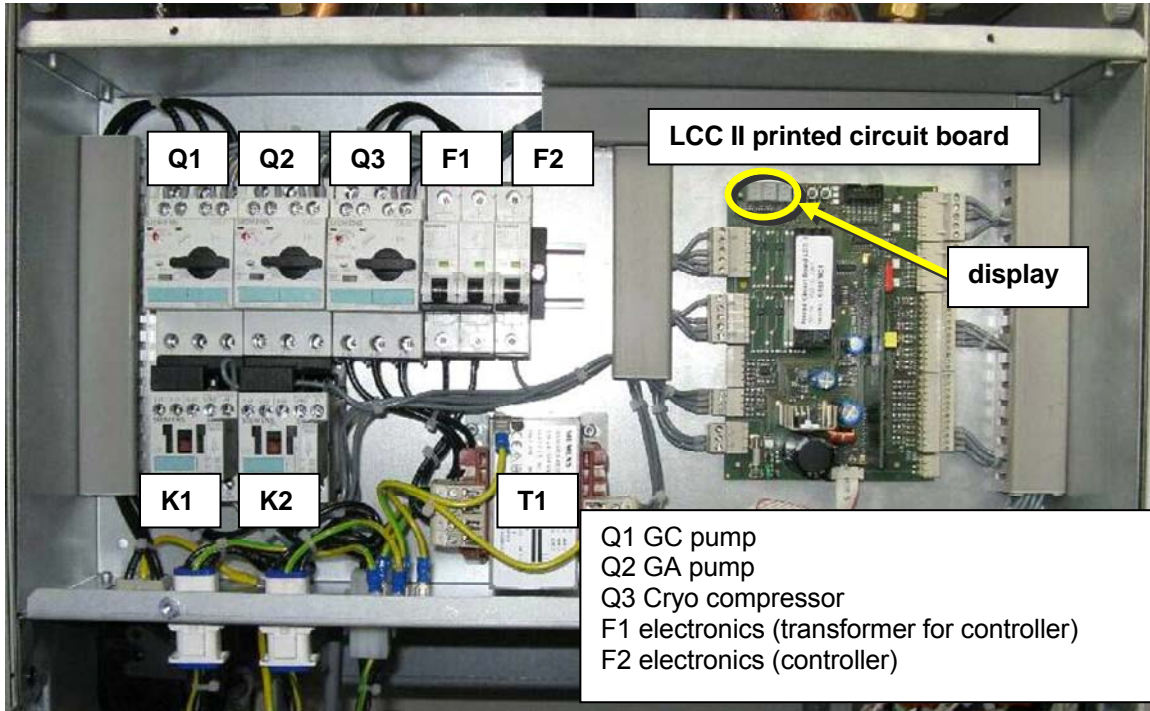
NOTE

*GC flow < 9 liter / minute, generates an interlock.
GA1 + GA2 < 36 liter / minute, generates an interlock*

5.8 SECONDARY CIRCUIT DRAINING

1. Switch off the LCCII in the MDU.
2. Remove the front cover by unscrewing the screws at the top.
3. Switch off the pump switch of the circuit which will be drained.

Figure 41 - The electronic box



Note: All switches are shown in the OFF position

4. Loosen the two knurled knobs on top of the control box by 3 turns and tilt the control box outwards until it rests upside down.
5. Protect the connectors from ingress with water by placing a plastic foil (see next picture) over the connectors and empty the circuit via the draining valve at the pump using the appropriate containers.

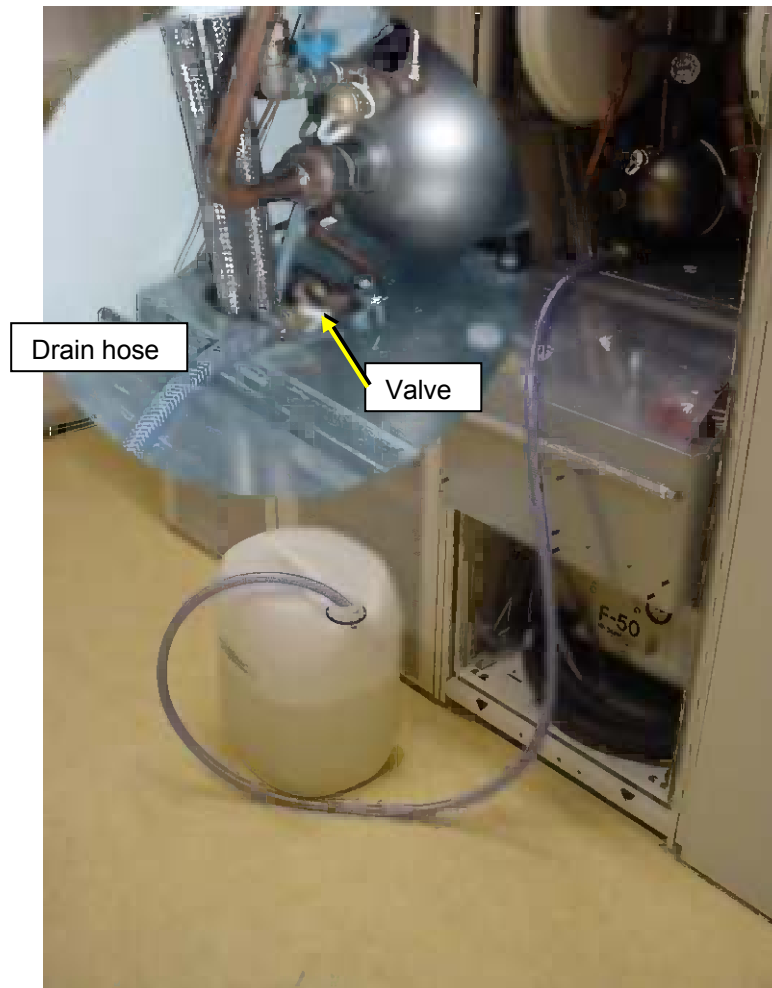
Figure 42 - The plastic cover



5.8.1 GC circuit draining

1. Connect a drain hose to the 'filling / drain port' (13) of the GC pump, put the other end in an empty canister. See Figure 43.
2. Close the GC supply and return shut off valves. Unless the hoses must be drained as well.
3. Open the 'filling / drain port' (13) of the GC pump.
4. When the flow stops close the 'filling / drain port' (13) of the GC pump and disconnect the drain hose.

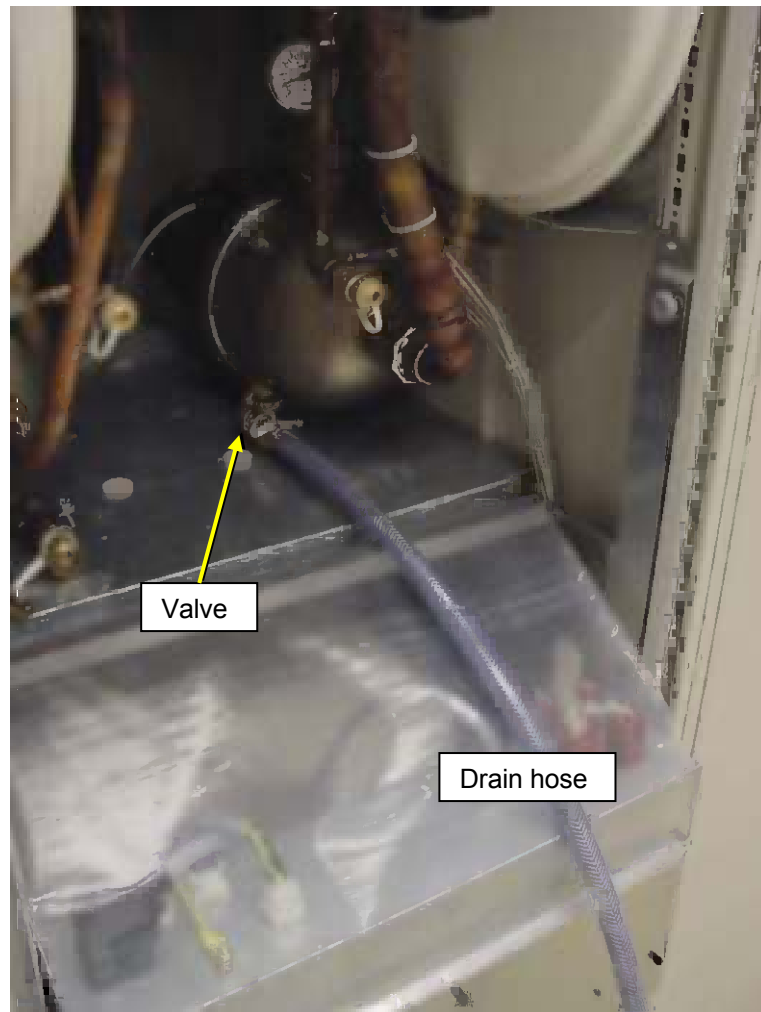
Figure 43 - connect a drain hose



5.8.2 GA circuit draining

1. Connect a drain hose to the 'filling / drain port' (13) of the GA pump, put the other end in an empty canister.
See Figure 44.
2. Close the GA1 and GA2 supply and return shut off valves. Unless the hoses must be drained as well.
3. Open the 'filling / drain port' (13) of the GA pump.
4. When the flow stops close the 'filling / drain port' (13) of the GA pump and disconnect the drain hose.

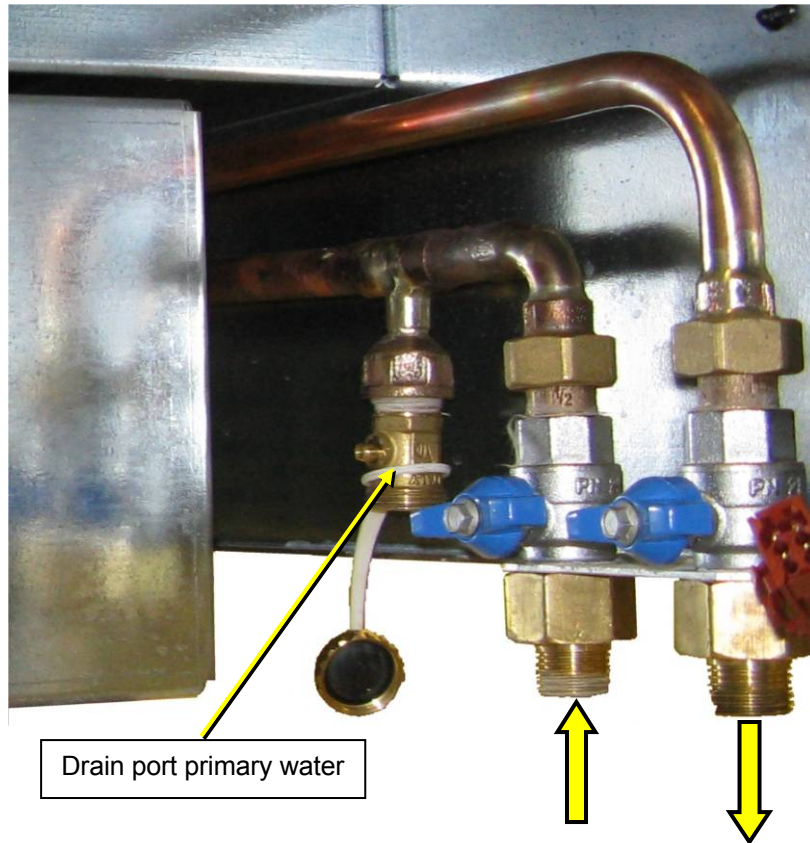
Figure 44 - connect a drain hose



5.9 PRIMARY CIRCUIT DRAINING

1. Switch off the LCCII in the MDU.
2. Close the primary water supply and return (hospital / chiller facility).
3. Open the primary water drain port. See Figure 45. Drain the coolant into a tank.

Figure 45 -The compressor connection inside the LCCII



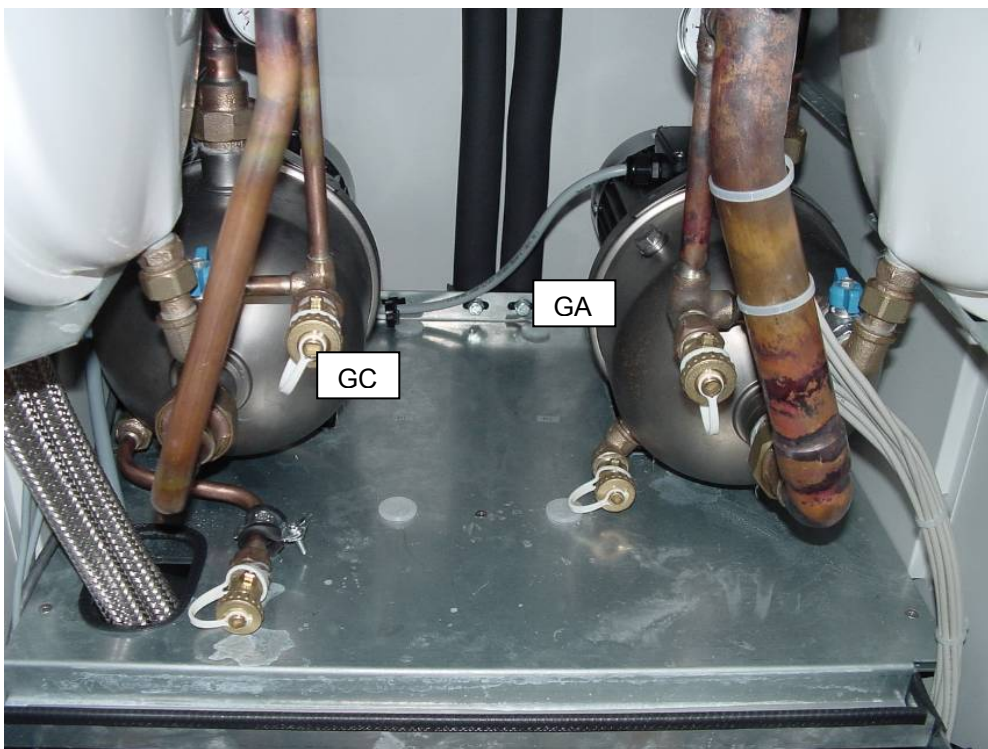
5.10 LCC II PUMP

Notice that there actually 4 different pumps for the LCC II, see Figure 46 :

- a pump for the gradient coil loop (GC) for 50 Hz
- a pump for the gradient coil loop (GC) for 60 Hz
- a pump for the gradient amplifier loop (GA) for 50 Hz
- a pump for the gradient amplifier loop (GA) for 60 Hz

1. Switch off the LCCII in the MDU.
2. Remove the front cover by unscrewing the screws at the top.
3. Loosen the two knurled knobs on top of the control box by 3 turns and tilt the control box outwards until it rests upside down.
4. Continue with the applicable pump replacement procedure.

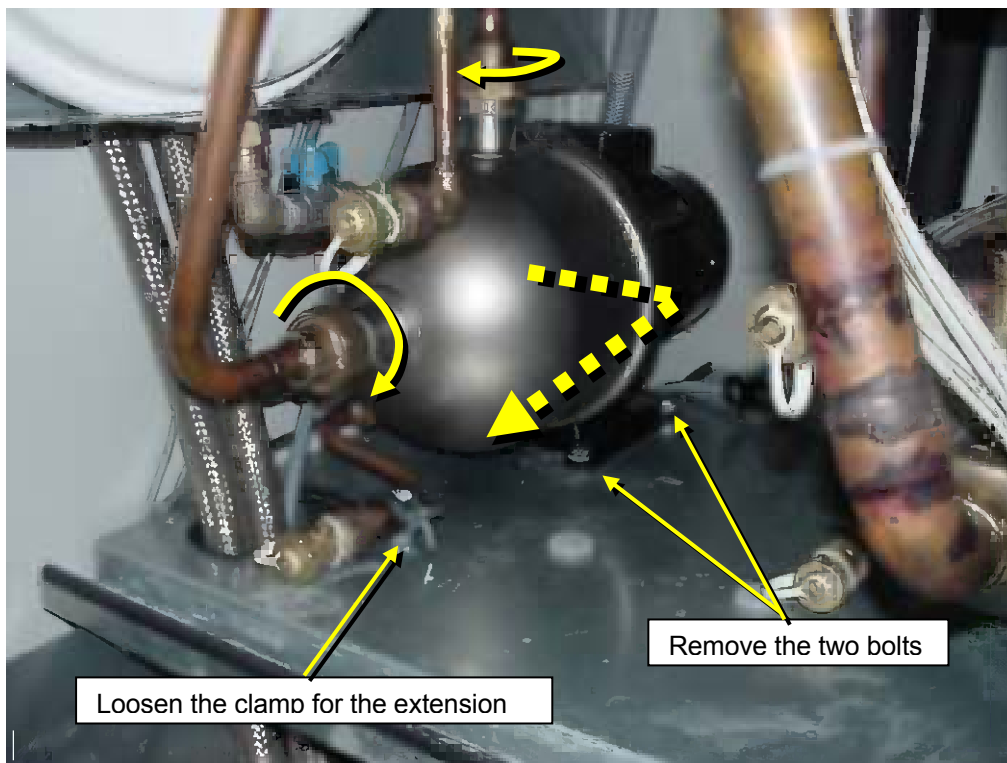
Figure 46 - Pumps



5.10.1 LCC II pump GC

1. Start to drain the applicable cooling loop. Refer to chapter 5.8 .
2. Unscrew the suction side and pressure side coupling of the pump.
3. Remove the two bolts from the pump foot.
4. Loosen the bracket that holds the drain extension pipe. The drain pipe must be reused with the new pump.
5. Slide the pump to the middle of the pump shelf and remove it from the cabinet.
6. Ensure that the correct replacement pump will be installed.
7. Slide the new pump in to the cabinet in the middle of the pump shelf.
8. Slide the pump to the left into the bracket. Connect the pressure side and suction side of the pump.
9. Route the pump power cable through the reusable cable binders and connect the connector to the electronics box.
10. Fill the GC circuit and continue from there until up and running again. Refer to chapter 5.5.

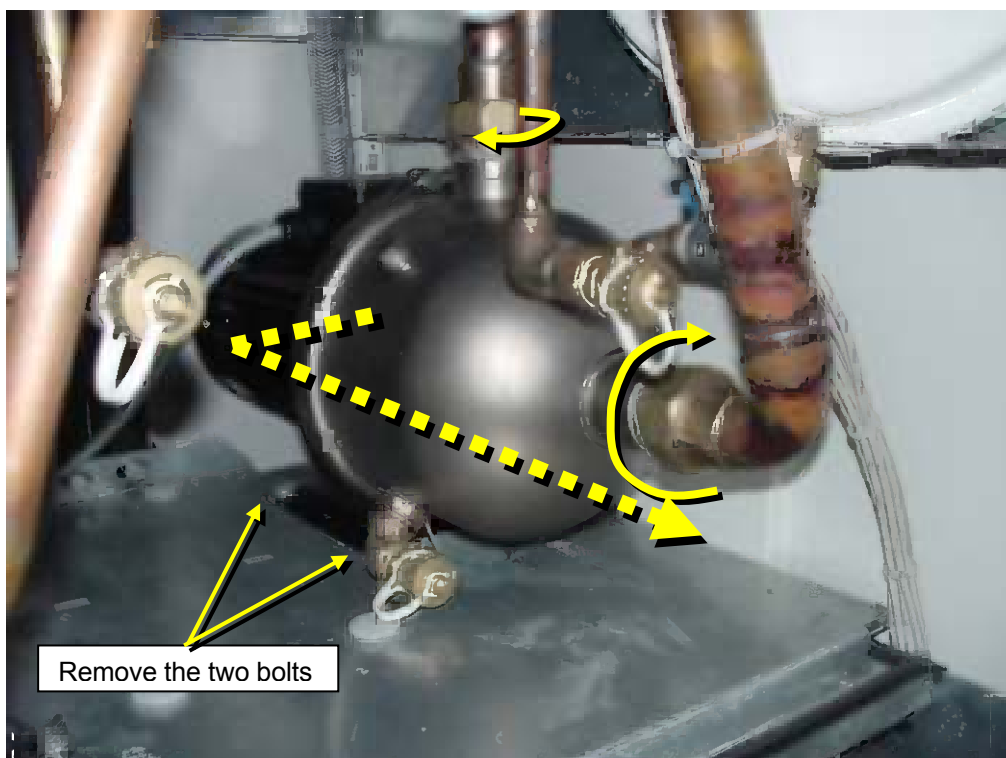
Figure 47 - LCCII pump GC



5.10.2 LCC II pump GA

1. Unscrew the suction side and pressure side coupling of the pump.
2. Remove the two bolts from the pump foot.
3. Loosen the bracket that holds the drain extension pipe.
4. Slide the pump to the middle of the pump shelf and remove it from the cabinet.
5. Ensure that the correct replacement pump will be installed.
6. Slide the new pump in to the cabinet in the middle of the pump shelf.
7. Slide the pump to the left into the bracket. Connect the pressure side and suction side of the pump.
8. Route the pump power cable through the reusable cable binders and connect the connector to the electronics box.
9. Fill the GC circuit and continue from there until up and running again. Refer to chapter 5.6

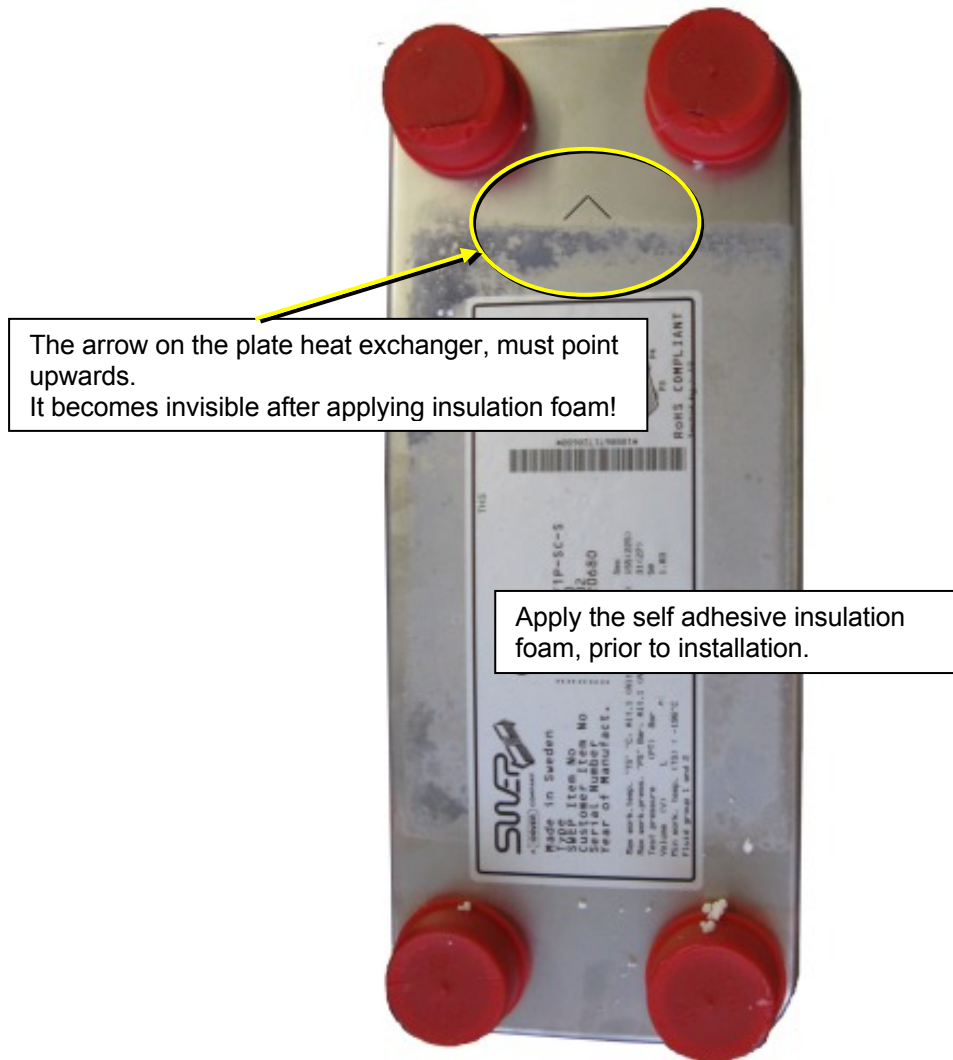
Figure 48 - LCCII pump GA



5.11 PLATE HEAT EXCHANGERS

The GC loop and GA loop have different plate heat exchangers.

Figure 49 - Plate heat exchanger



5.11.1 LCC II plate heat exchanger GC

NOTE

The plate heat exchanger is not front replaceable. Access from the left side is required.

1. Drain the GA loop of the 1LCCII (refer to chapter 5.8.2), only if the cabinet must be moved to gain access from the left and GA hoses have to be disconnected from the LCCII. If the GA hoses are not fixed to a ladder tray, it could be an option to disconnect the hoses from the gradient amplifier and pull them towards the LCCII as far as needed.
2. Drain the GC loop as described in chapter 5.8.1.

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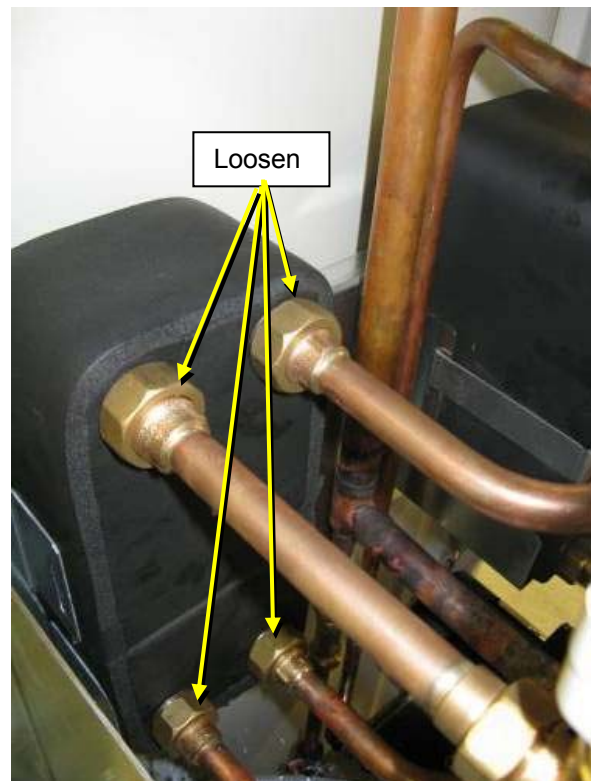
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3. Drain the primary side of the LCCII as described in chapter 5.9.
4. If the cabinet must be moved to gain access, disconnect all hoses. Otherwise they can remain connected.
5. Loosen the spring clamp that holds the heat exchanger in position, with the help of a screwdriver. See Figure 50.
6. Slightly loosen all 4 connections until they can be loosened by hand. See Figure 51. Finally disconnect the connections from the heat exchanger.
7. Slide the plate heat exchanger upwards and remove it from the cabinet, the 4 rubber gasket rings might fall on the pump shelf.
8. Prepare the new replacement heat exchanger. Notice the arrow on the plate heat exchanger, it should point upwards.
9. Apply the supplied insulation foam to the plate heat exchanger.
10. Slide the plate heat exchanger in its bracket and install the clamp to hold it.
11. Ensure that 4 rubber gasket rings are available.
12. Connect all 4 plumbing connections to the plate heat exchanger, with a rubber gasket ring in between is. Do not over tighten the connection, since that would damage the rubber gasket ring.
13. Install the side-cover and move the cabinet back to its original position (if applicable).
14. Connect the disconnected hoses to the cabinet (if applicable).
15. Continue with filling of the LCCII in chapter 5.1, 5.5 and if applicable 5.6
16. Continue with chapter 5.7 to switch on the pumps.

Figure 50 - Loosen the clamp**Figure 51 – Loosen all connections**

5.11.2 LCC II plate heat exchanger GA

NOTE

The plate heat exchanger is not front replaceable. Access from the right side is required.

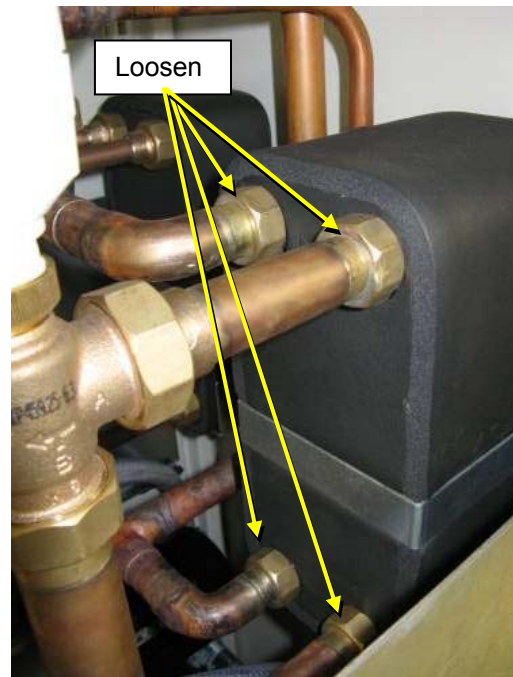
1. Drain the GC loop of the LCCII (refer to chapter 5.8.1), only if the cabinet must be moved to gain access from the right and GC hoses have to be disconnected from the LCCII.
2. Drain the GA loop as described in chapter 5.8.2.
3. Drain the primary side of the LCCII as described in chapter 5.9.
4. If the cabinet must be moved to gain access, disconnect all hoses. Otherwise they can remain connected.
5. Loosen the spring clamp that holds the heat exchanger in position, with the help of a screwdriver.
6. Slightly loosen all 4 connections until they can be loosened by hand. See Figure 53. Finally disconnect the connections from the heat exchanger.
7. Slide the plate heat exchanger upwards and remove it from the cabinet, the 4 rubber gasket rings might fall on the pump shelf.

8. Prepare the new replacement heat exchanger. Notice the arrow on the plate heat exchanger, it should point upwards.
9. Apply the self adhesive insulation material to the plate heat exchanger.
10. Slide the plate heat exchanger in its bracket and install the clamp to hold it.
11. Ensure that 4 rubber gasket rings are available.
12. Connect all 4 plumbing connections to the plate heat exchanger, with a rubber gasket ring in between is. Do not over tighten the connection, since that would damage the rubber gasket ring.
13. Install the side-cover and move the cabinet back to its original position (if applicable).
14. Connect the disconnected hoses to the cabinet (if applicable).
15. Continue with filling of the LCCII in chapter 5.1, 5.6 and if applicable 5.5.
16. Continue with chapter 5.7 to switch on the pump.

Figure 52 - Loosen the clamp



Figure 53 – Loosen all connections



5.12 LCC II ELECTRONIC BOX

Notice that there are two different types of electronic boxes:

45221330188x for APD systems

45221330189x for SHI systems

The difference is in the switch for the compressor.

All connectors have key-pins and will fit to the correct connector only.

1. Switch OFF the mains power to the LCCII in the mains distribution unit.
2. Remove the LCCII front cover.
3. Loosen the curled nuts and tilt the electronic box forward.
4. Disconnect all cables from the electronic box. See Figure 54.
5. Unscrew the hinge pints at the bottom on the box.
6. Install the replacement box in reverse order.
7. Open the electronic box.
8. Check / change the voltage programming. Refer to chapter 2.3.
9. Switch on the mains power to the LCCII in the mains distribution unit.
10. Switch on Q1, Q2, Q3, F1 and F2. Notice that the cryo compressor starts running and the LCCII starts up, showing 1 1 on the pcb display. Eventually pumps start running and the display shows status 2 2. See Figure 55.
11. Close the electronic box.
12. Install the LCCII front cover.

Figure 54 – Bottom of the electronic box

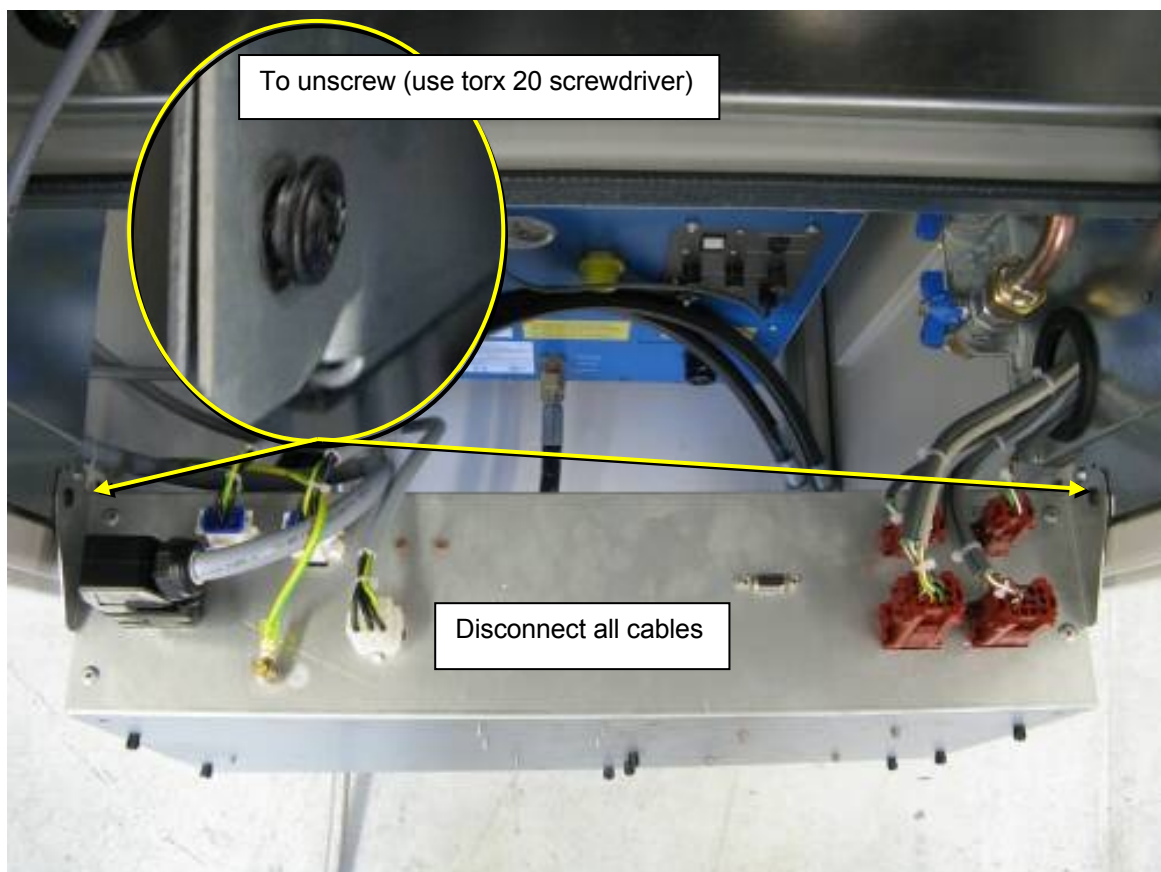
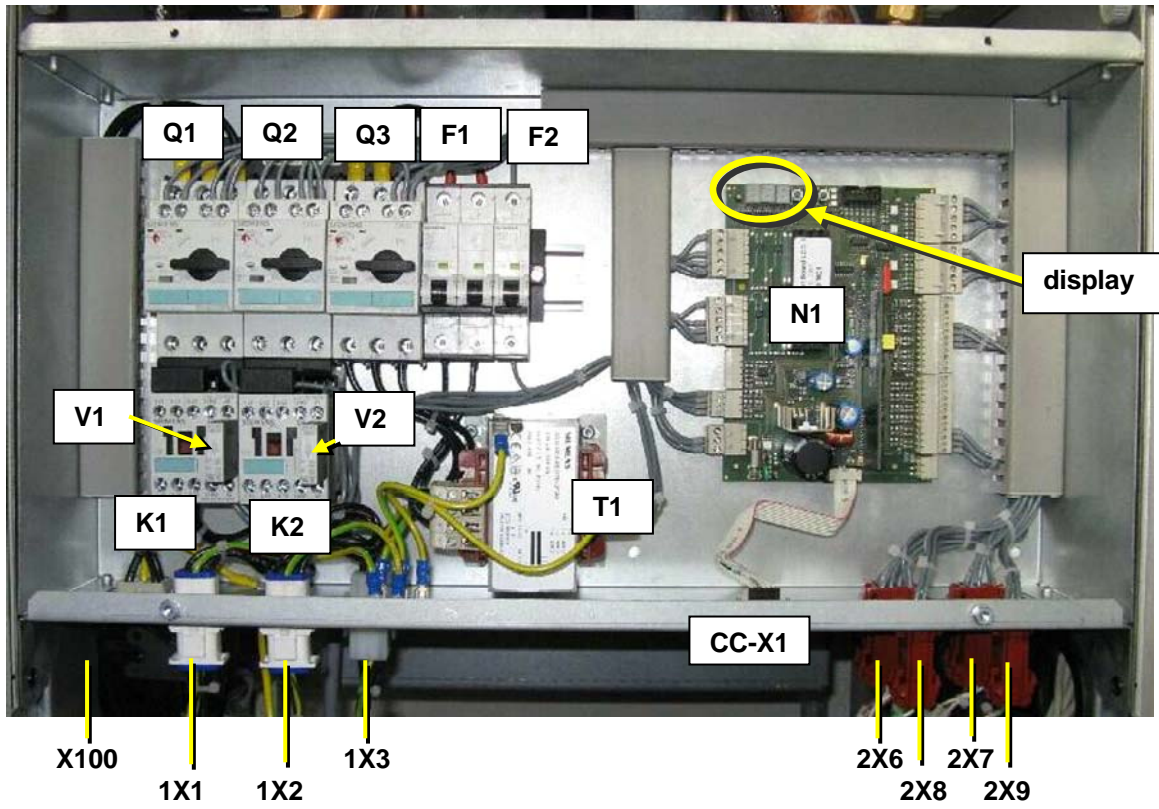


Figure 55 – Overview of the electronic box



5.13 LCC II PRINTED CIRCUIT BOARD

1. Remove the LCCII front cover.
2. Open the electronic box.
3. Switch off F1. See Figure 56.
4. Disconnect all connectors and the ribbon cable. Do not unscrew the wiring from the connectors!
5. Loosen the 4 notches that hold the board, by squeezing the latch with pliers and pull the board forward. See Figure 57.
6. Install the new board in reverse order.
7. Switch on F1. Notice that the LCCII starts up, showing 1 1 on the pcb display. Eventually pumps start running and the display shows status 2 2.
8. Close the electronic box.
9. Install the LCCII front cover.

Figure 56 – Overview of the electronic box

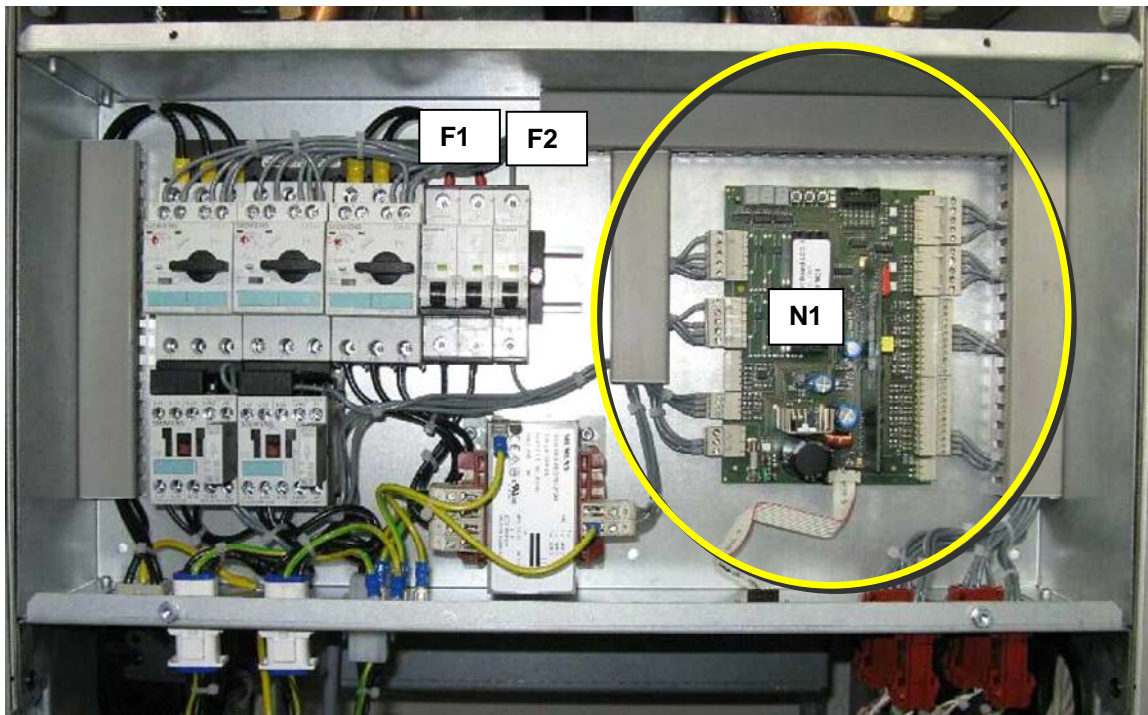
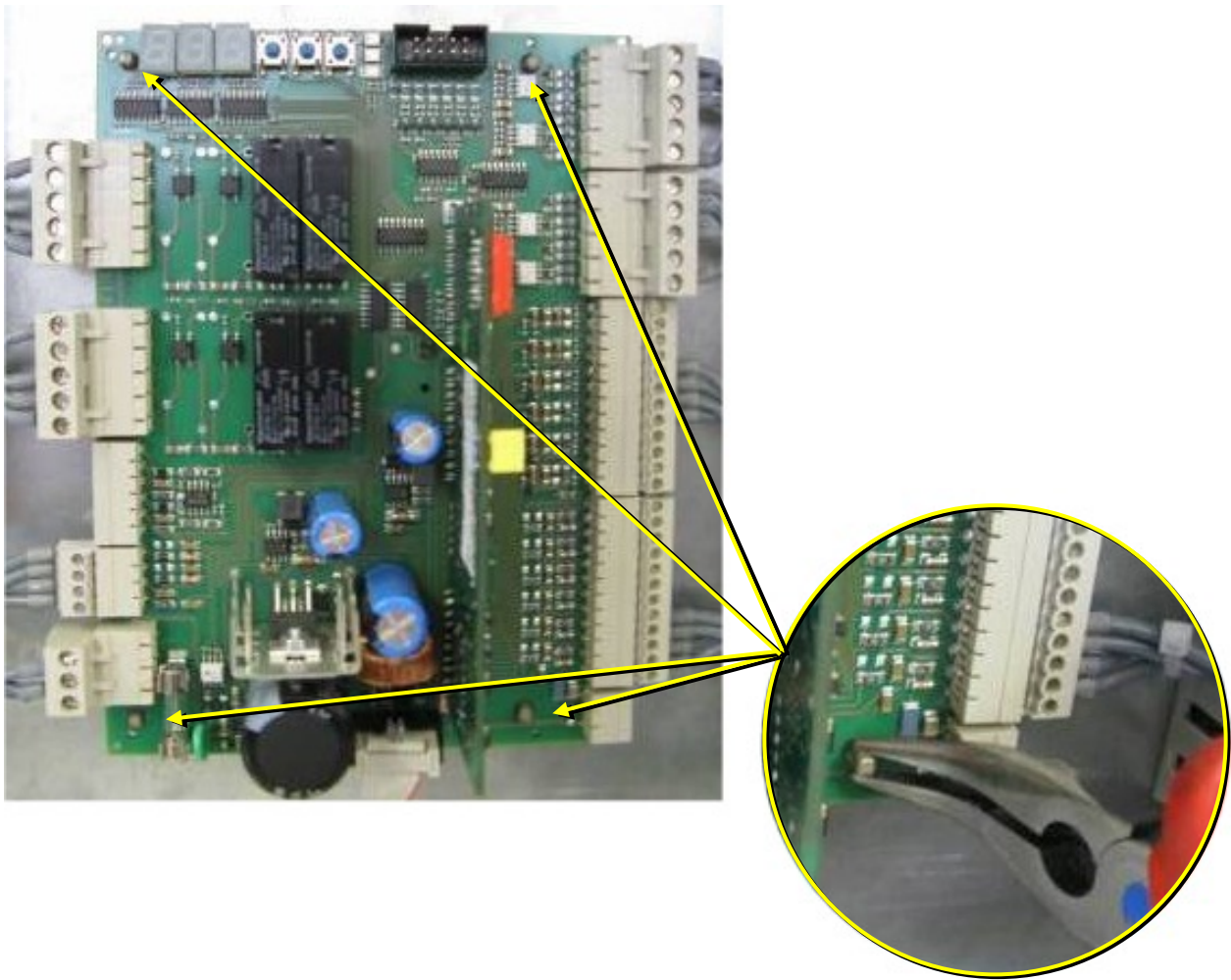


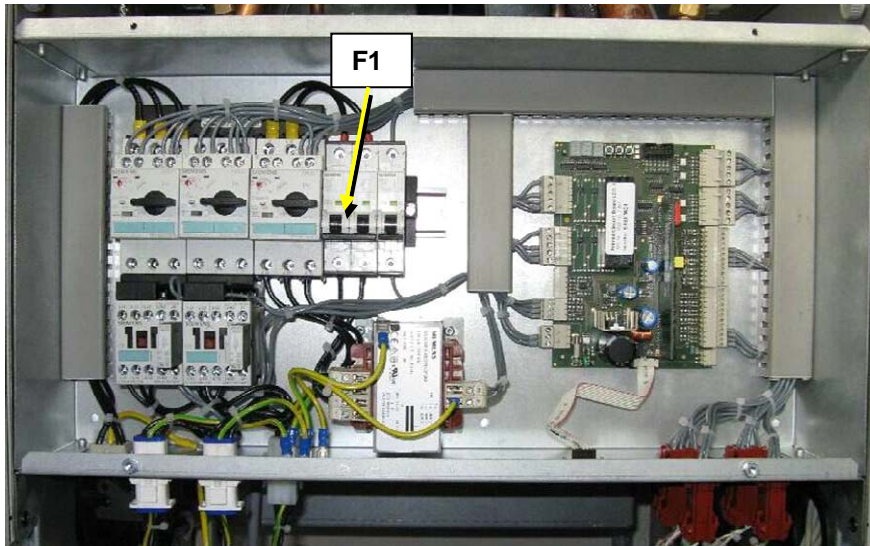
Figure 57 - The board



5.14 LCC 3 WAY VALVE ACTUATOR

1. Remove the LCCII front cover.
2. Open the electronic box.
3. Switch off F1 to switch off the electronics. See Figure 58.

Figure 58 – Overview of the electronic box



10. Turn the white knob to release the tension of the valve. Loosen the brass curled ring, underneath the actuator, to remove it from the valve. See Figure 59.
11. Open the end cover and unplug the cable. See Figure 60.

Figure 59 – unscrew the brass ring

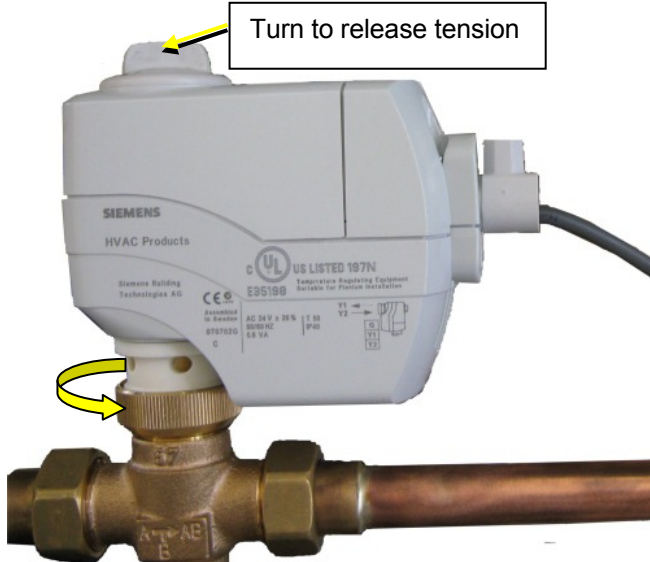


Figure 60 – unplug the cable

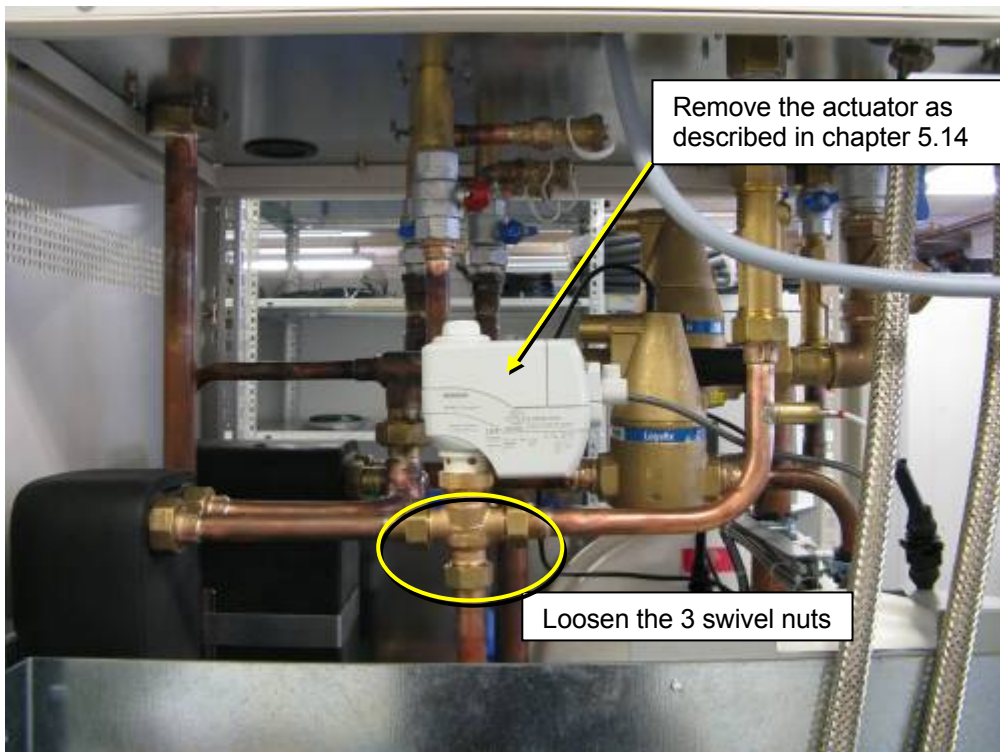


12. Plug the cable on to the new actuator.
13. Close the cover and install the actuator on top of the 3-way valve.
14. Switch on F1. Notice that the LCCII starts up, showing 1 1 on the pcb display. Eventually pumps start running and the display shows status 2 2.
15. Close the electronic box.
16. Install the LCCII front cover.

5.15 LCC II 3-WAY-VALVE

1. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
2. Remove the affected actuator as described in chapter 5.14.
3. Loosen the 3 swivel nuts. See Figure 61.
4. Replace the 3 way valve in reversed order.

Figure 61 - 3-way valve



5.16 LCC II EXPANSION VESSEL 8L

Required tools:

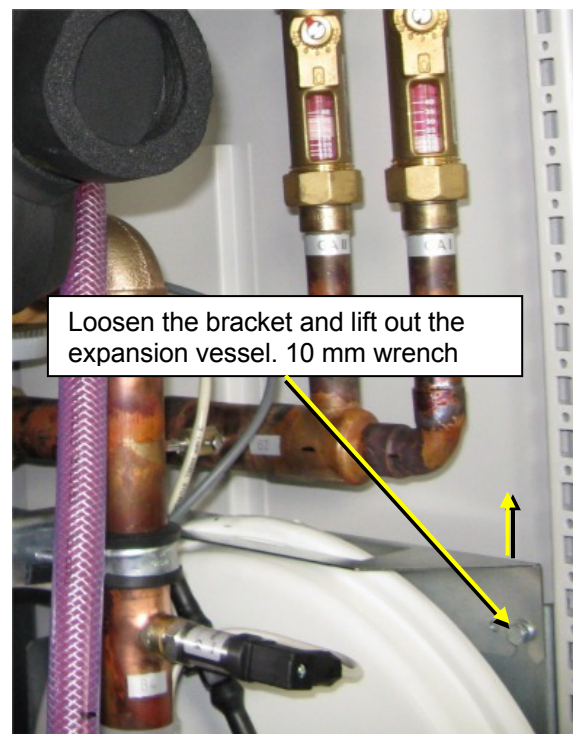
- 10 mm wrench
- 26 mm wrench (or adjustable wrench)

1. Switch off the LCCII in the MDU.
2. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
3. Disconnect the coupling of the affected expansion vessel.(26 mm wrench)
4. Loosen the bracket (10mm wrench) and lift it at the front to free the expansion vessel.
5. Install the new vessel in reversed order.
6. Pressurize the new expansion vessel to 1 bar air pressure. Refer to chapter 5.4
7. Fill the affected loop. Refer to chapter 5.5 or 5.6.
8. Switch on the LCCII .

Figure 62 - Coupling

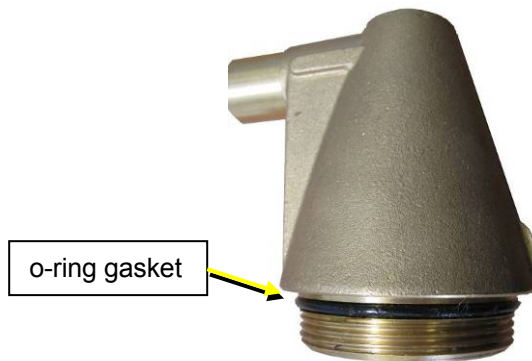


Figure 63 - Bracket



5.17 LCC II CAP OF AIR BLEEDER

Figure 64 - LCCII cap of air bleeder

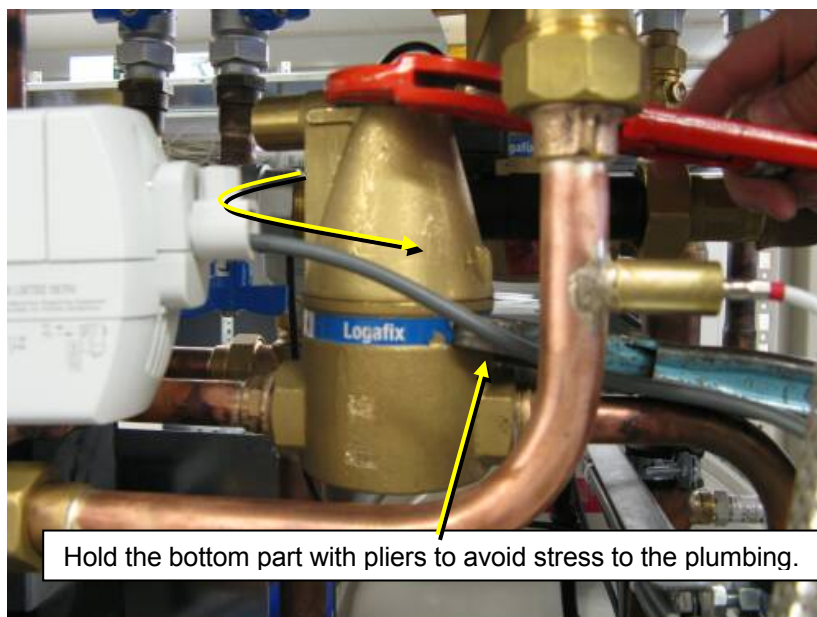


NOTE

The 'LCCII cap of air bleeders' of the GC and GA loop are identical. The part which remains connected to the plumbing is different for each loop and is not an FRU.

1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
4. Loosen the cap of the air bleeder with the help of pliers or an (adjustable) wrench. When loosening it, hold the base unit, which remains connected to the plumbing, with pliers or a (adjustable) wrench.
5. Install the new cap of air bleeder in reverse order.

Figure 65 – Loosen the cap of airbleeder



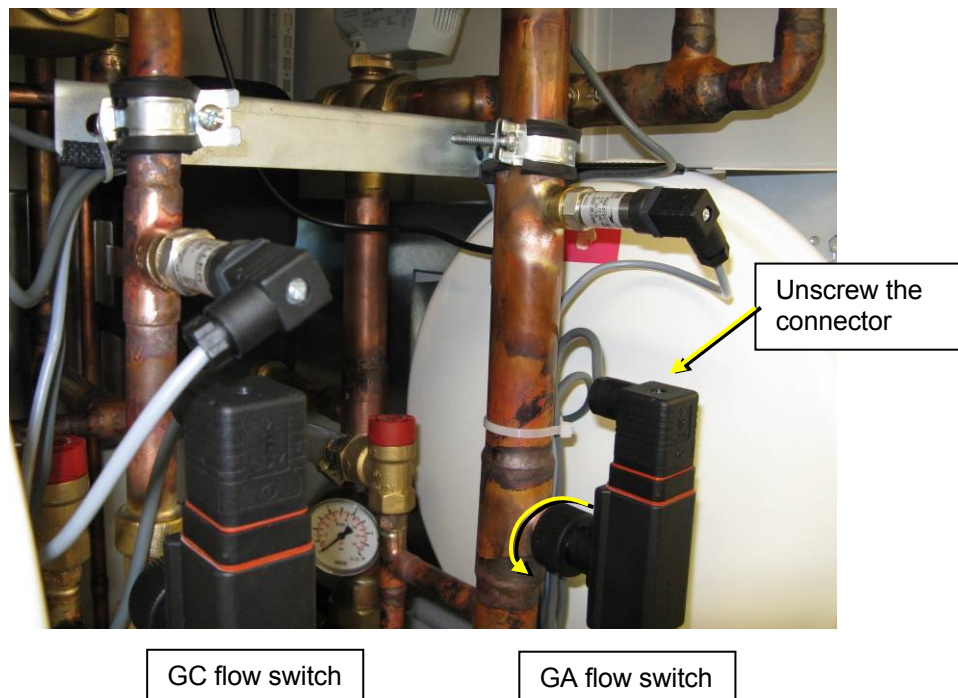
5.18 LCC II FLOW SWITCH

Notice that the GC loop and GA loop do have different flow switches.

- GC loop: has a 10 l/m flow switch.
- GA loop: has a 40 l/m flow switch.

1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
4. Disconnect connector from the flow switch of the affected cooling loop, by unscrewing it from the flow switch.
5. Unscrew the defective flow switch from the plumbing and remove it.
6. Install the new flow switch reverse order.

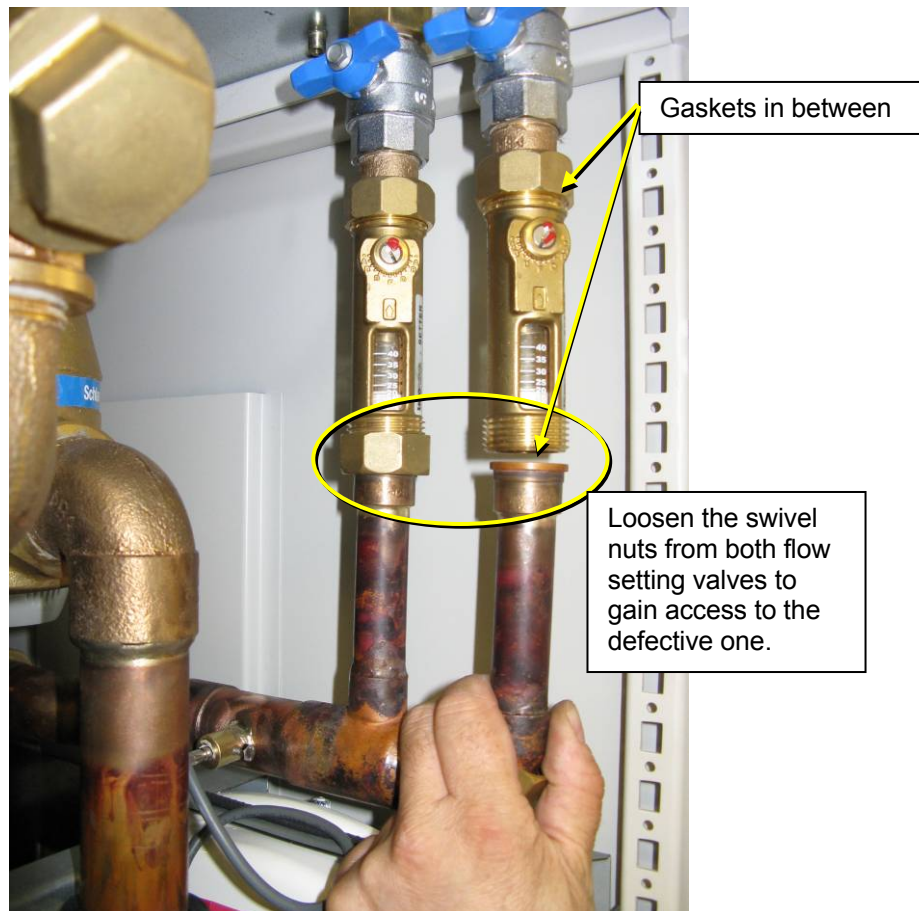
Figure 66 - GC and GA flow switch



5.19 LCC II FLOW SETTING VALVE

1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
4. Loosen two nuts of the flow setting valve and remove it from the plumbing from the plumbing.
5. Install the new flow setting valve in reverse order, use new gaskets. Do not over tighten the connections which have rubber gaskets.
6. Fill the affected loop. Refer to chapter 5.5 or 5.6. Check for leaks.

Figure 67 - The flow setting valve



5.20 LCC II PRESSURE GAUGE

1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
4. Unscrew the pressure gauge of the affected cooling loop from the plumbing.
5. Wind supplied Loctite 55 tape (check out instructions at the tape packaging) around the thread of coupling of the gauge along with the thread.
6. Gently screw the gauge into the plumbing, be careful not to damage the thread in the plumbing.
7. Fill the affected loop. Refer to chapter 5.5 or 5.6. Check for leaks.

Figure 68 - The pressure gauge



5.21 LCC II SAFETY VALVE

1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Depending on the affected loop, drain either the gradient coil loop (GC) or gradient amplifier loop (GA). Refer to chapter 5.8.
4. Unscrew the pressure gauge of the affected cooling loop from the plumbing. Use two wrenches, one to hold the plumbing, one to unscrew the safety valve. Refer to Figure 69.
5. Wind supplied Loctite 55 tape (check out instructions at the tape packaging) around the threaded coupling along with the thread. Refer to Figure 70.
6. Gently screw the gauge into the plumbing, be careful not to damage the thread in the plumbing.
7. Fill the affected loop. Refer to chapter 5.5 or 5.6. Check for leaks.

Figure 69 - Loosen the safety valve

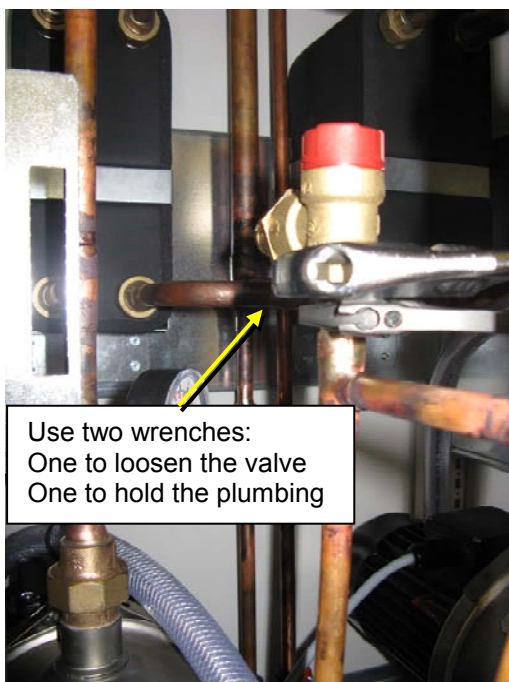


Figure 70 - Wind with Loctite 55



5.22 LCC II TEMPERATURE SENSOR

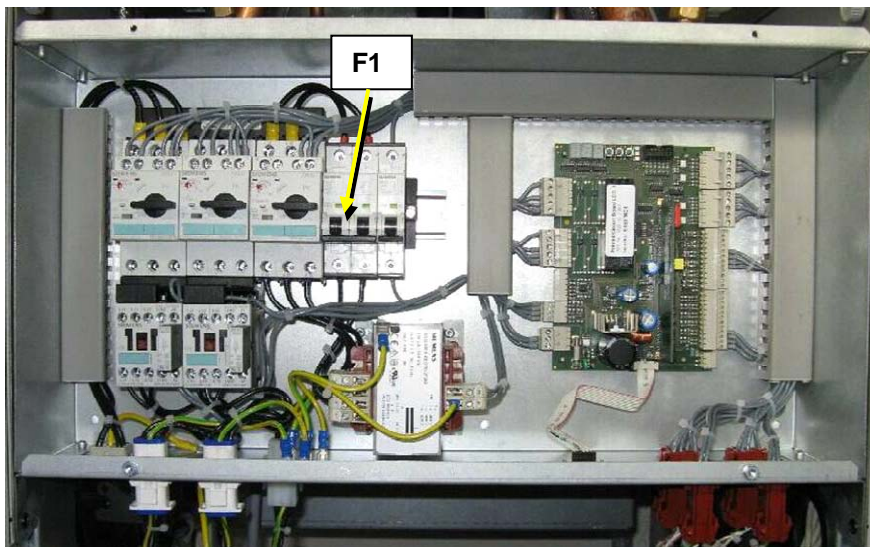
Purchase a heat sink paste (e.g from a local computer shop) locally. To ensure proper functionality, a heat sink paste must be applied to the sensor, prior to installation.

NOTE

The temperature sensors are inserted in a closed chamber. Draining prior to replacement is not needed.

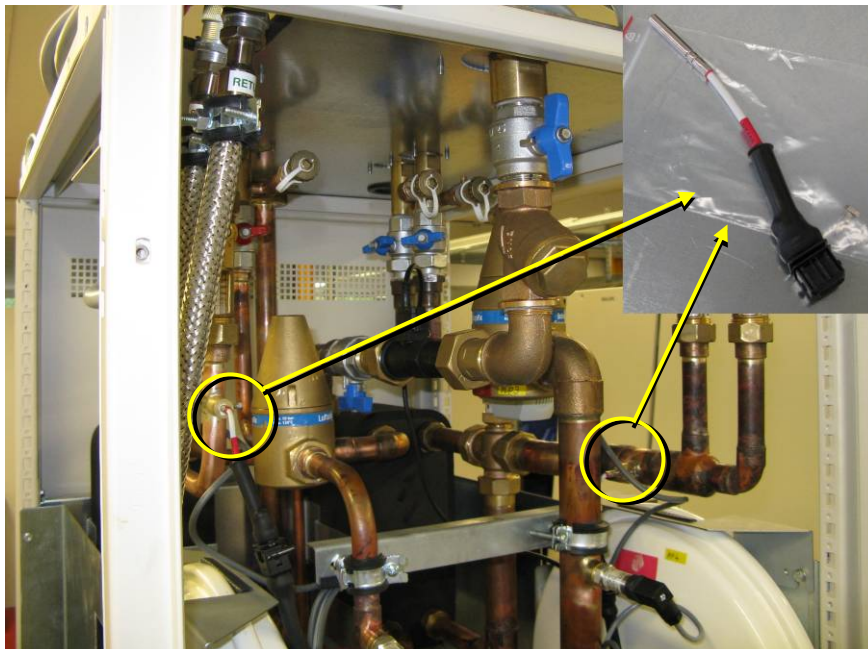
1. Remove the LCCII front cover.
2. Open the electronic box.
3. Switch off F1 to switch off the electronics. See Figure 71.

Figure 71 – Overview of the electronic box



4. Locate the affected sensor. See Figure 72
5. Slightly loosen the screw which holds the sensor.
6. Push the metal bracket of its connector to release the connector.
7. Pull the defective temperature sensor from the chamber in the plumbing.
8. Apply heat sink paste to the new temperature sensor and inset it in the chamber.
9. Tighten the screw hand tight. Be careful not to damage the temperature sensor.
10. Connect the connector.
11. Switch on F1.
12. Close the electronic box.
13. Install the LCCII front cover.

Figure 72 – Location of the temperature sensors



5.23 LCC II STRAINER OF DIRT TRAP (PRIMARY FILTER)

NOTE

This filter is a protection for the LCCII to catch incidental debris from the primary supply coolant.

The customer must install a larger capacity external filter (not a Philips part) between hospital connections and the primary water hoses, if the hospital cooling water system or chiller coolant doesn't meet the primary water specification, according site planning reference document.

Required tool: 32 mm Open ended wrench (or adjustable wrench).

Procedure:

1. Switch off the LCCII in the gMDU.
2. Close the ball valves before and after the filter in the primary loop.
3. Remove the insulation temporary, to gain access to the dirt trap.
4. Unscrew the dirt trap. (use a 32 mm wrench)
5. Remove the strainer and rinse it with water until it is clean.
6. Insert the cleaned or new replacement strainer in the dirt trap and install it in the dirt trap housing.
7. Install the insulation.
8. Open the ball valves before and after the filter in the primary loop.
9. Switch on the LCCII in the gMDU.

Figure 73 - The primary filter 1

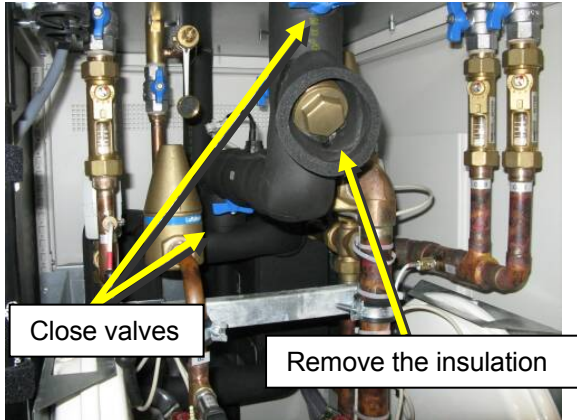


Figure 74 - The primary filter 2

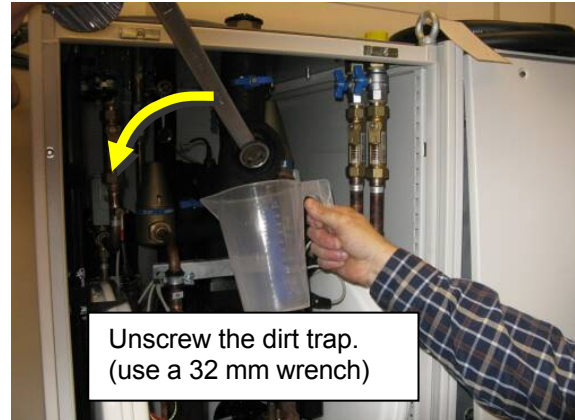
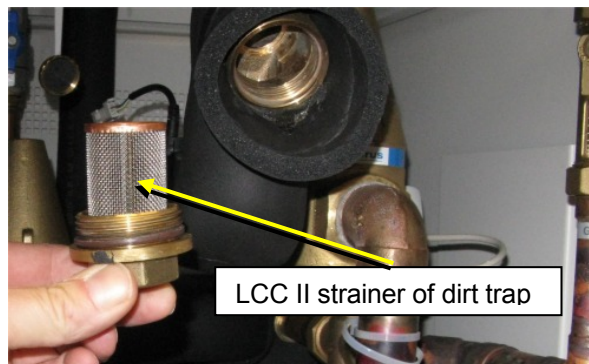


Figure 75 - The primary filter 3



5.24 LCC II PRIMARY FLOW AND TEMPERATURE SENSOR

Figure 76 - LCC II primary flow and temperature sensor

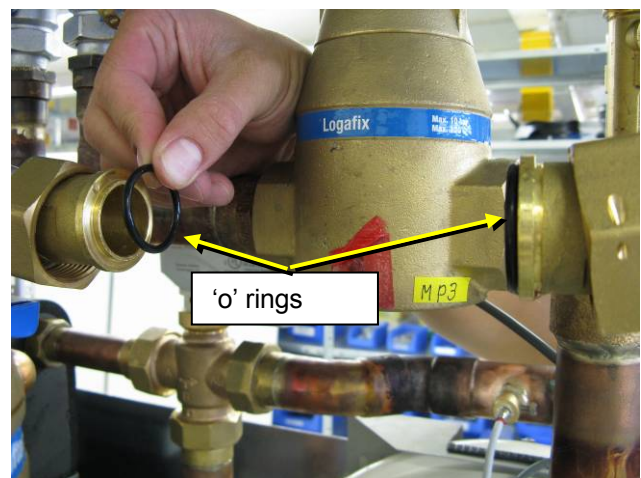


1. Switch off the LCCII in the MDU.
2. Remove the front cover.
3. Close the ball valves before the filter and after the 'LCC II primary flow and temperature sensor' in the primary loop.
4. Disconnect the connector to the 'LCC II primary flow and temperature sensor'.
5. Remove the insulation from the sensor.
6. Unscrew the both swivel nuts that hold the sensor. Use one wrench to hold the sensor and the other one to loosen the couplings. Refer to Figure 77.
7. Catch the little remaining coolant in the supplied measuring jug.
8. Install the new supplied 'o' rings at the fittings. Install the new flow switch reverse order.
9. Wrap the new insulation around the sensor.
10. Connect the cable to the sensor.
11. Open the ball valves.
12. Switch on the LCCII in the MDU.
13. Install the front cover.

Figure 77 – Primary flow and temp sensor



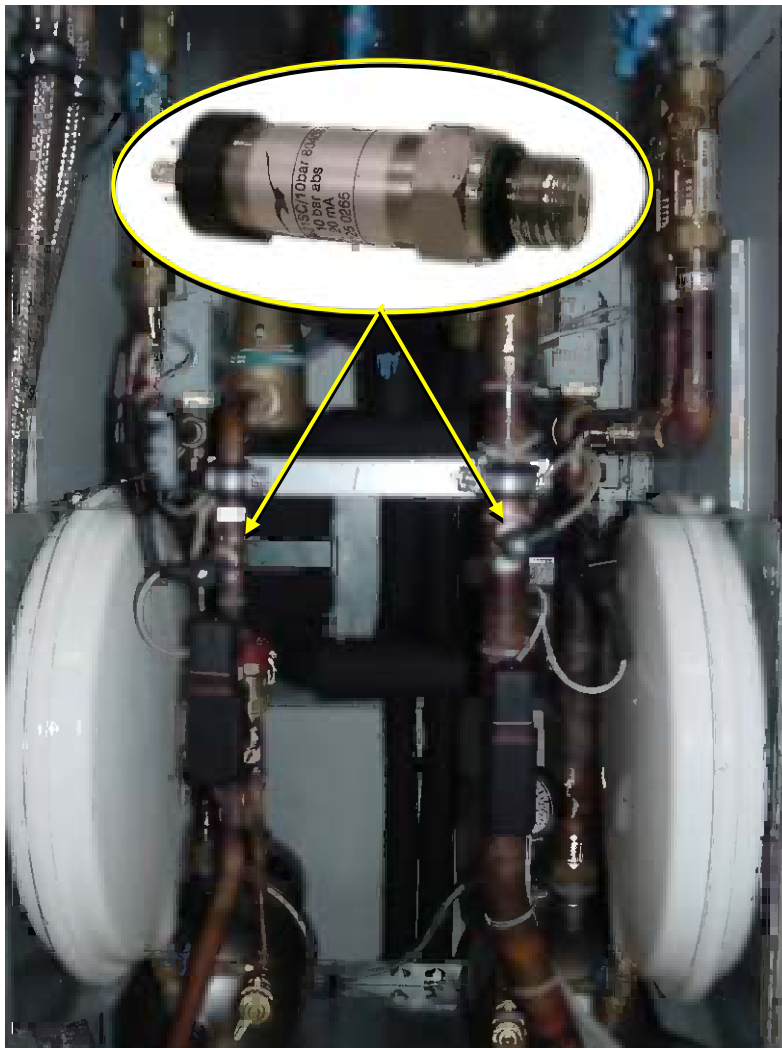
Figure 78 - 'o' rings



5.25 LCC PRESSURE SENSOR

1. Remove the LCCII cabinet front cover.
2. Switch OFF the mains power to the LCCII in the mains distribution unit.
3. Drain the affected circuit.
4. Disconnect the connector from the affected sensor.
5. Unscrew the affected sensor using a wrench, size 19mm . See Figure 79.
6. Replace the defect sensor with a new one. Put the new O-ring over the threaded end of the sensor.
7. Install the new sensor by hand.
8. Subsequently tighten the sensor with a wrench to a maximum 1 complete turn.
9. Connect the connector to the sensor and fasten the screw. Notice that the different connector contacts do have different sizes, therefore it fits only in one way. If required, the connector of the sensor can be rotated slightly.
10. Fill the circuit.
11. Check for leaks.
12. Switch ON the mains power to the LCC in the mains distribution unit.

Figure 79 - the pressure sensors



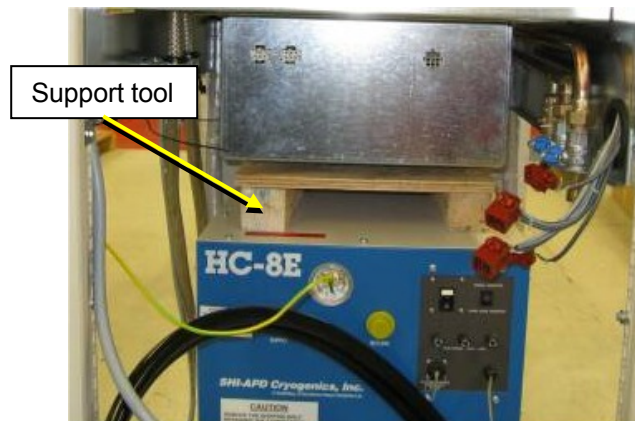
5.26 LCC STEP DOWN TRANSFORMER

WARNING

Weight of the transformer is 35 kg. Two persons are needed to lift the FRU.

1. Remove the LCCII front cover.
2. Switch off the LCCII and remove the electronic box as described in chapter 5.12.
3. Put the wooden support tool underneath the transformer. See Figure 80.

Figure 80 - support tool



4. Disconnect all cables from the transformer.
5. Unscrew the transformer bolts from the pump shelf to lower the transformer on to the wooden support.
6. Install the replacement transformer in the opposite order.

Figure 81 - Transformer removed



5.27 INSTALLATION OF THE PRIMARY HOSES

1. Connect the primary hoses (hospital inlet and outlet) to the connections on top of the LCC II.
2. Cut the primary hoses to length and install the couplers as indicated in the instructions which come with the coupler. Ensure that the 'distance rings' are installed in between the clamp halves (this is only required for the primary hoses).

Figure 82 - Primary hoses

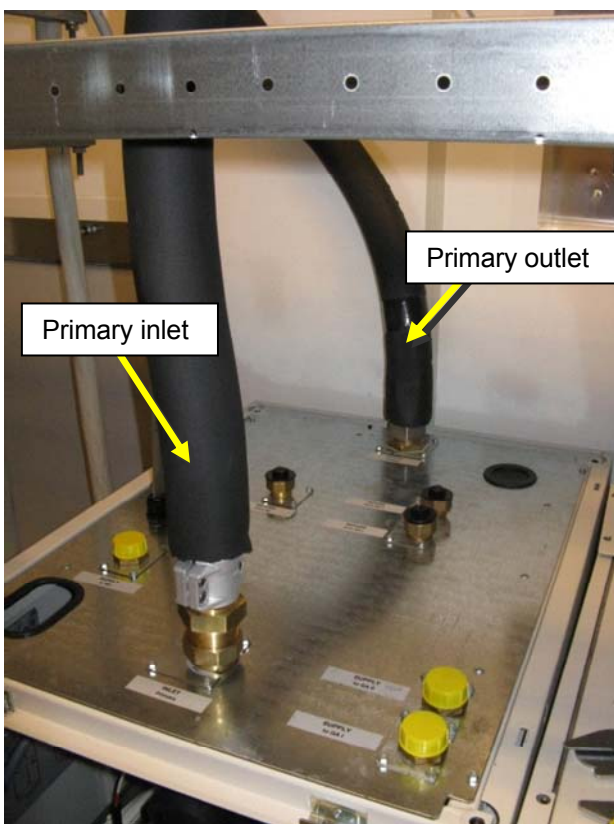
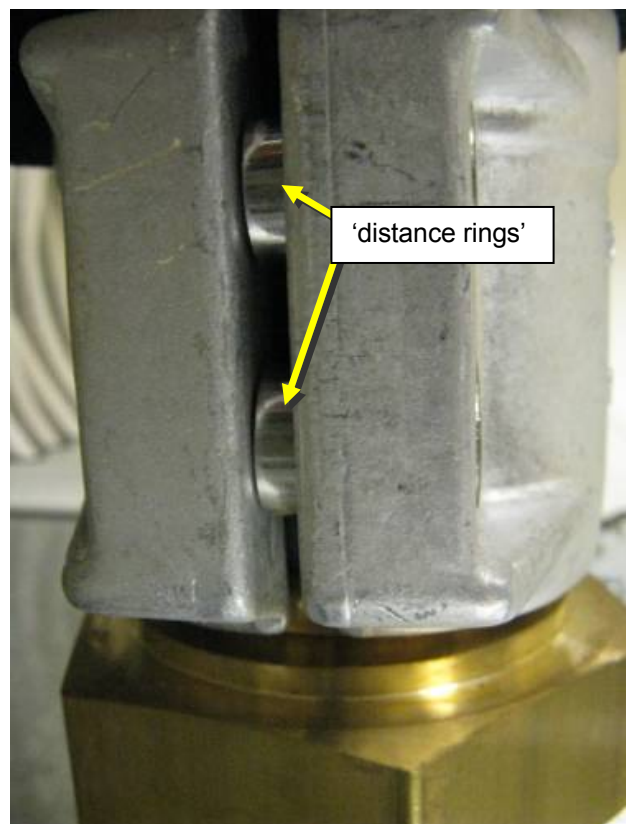


Figure 83 - Primary coupling



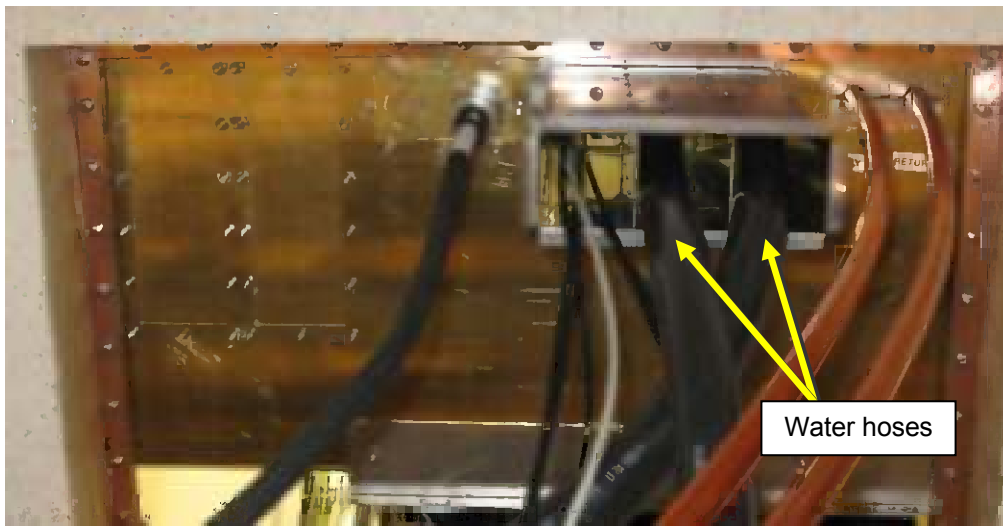
5.28 INSTALLATION OF THE GRADIENT COIL HOSES

NOTE

*Gradient coil hoses are to be cut to length at the LCC II side.
Work from the gradient coil to the LCC II.*

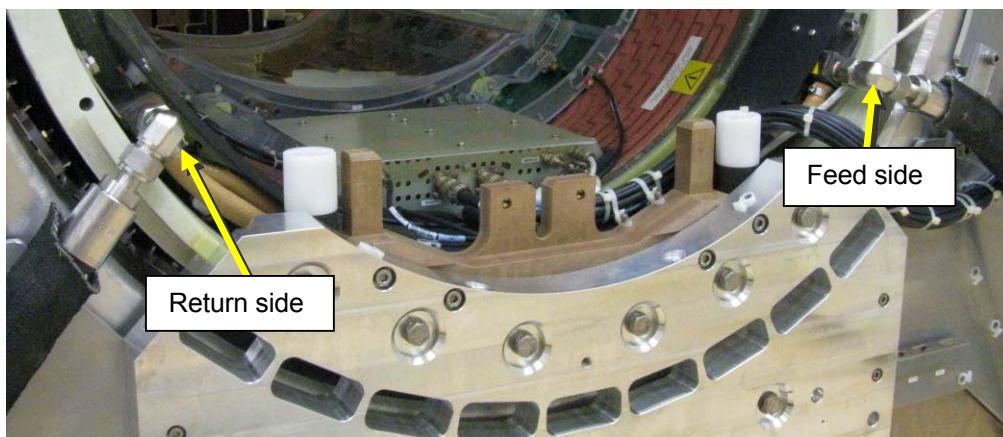
1. Route the hoses across and around the magnet as shown in drawings Z6-4.8 and Z6-4.10 and via the ladder tray. Route the two water hoses for the gradient coil through the SFB (work from the gradient coil to the LCC II). See Figure 84.

Figure 84 - Feed through SFB of the water hoses for the gradient coil; technical room side



2. Connect the water hose 'GC supply' to the gradient coil feed side manifold. See Figure 85.
3. Connect the water hose GC return' to the return side manifold. See Figure 85

Figure 85 - Hose connections



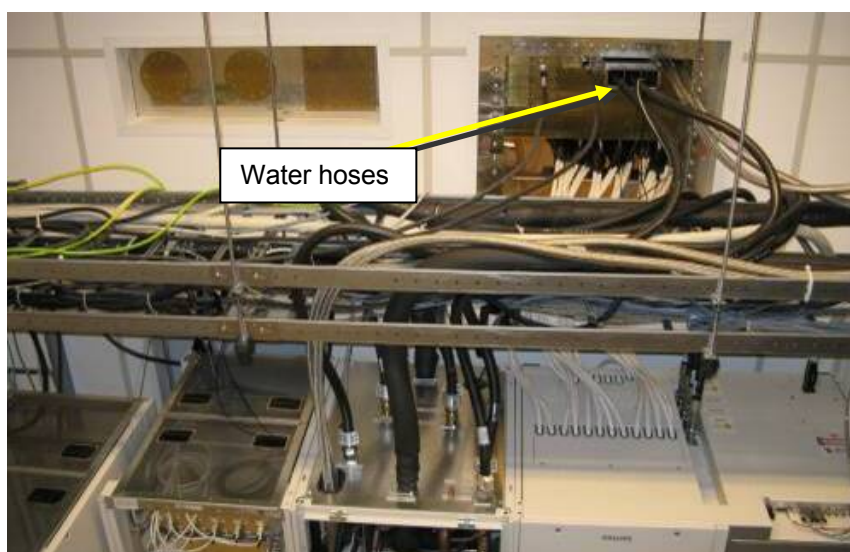
4. Insert both couplings into their coil fitting. Ensure that the tube is totally pushed into the coil fitting and fasten the nut finger tight.
5. Mark the nut in this position, and tighten the nut for 0.5 to 0.75 turn, using the mark as a reference.
6. Install a 'splash guard' to prevent water from leaking onto the hybrid board in case of a leaking hose or coupling. The splashguard has to be installed underneath the RF-cabling and over the interconnection hoses and the manifolds itself. See Figure 86.
7. Attach both hoses to the front ring frame.
8. Pull the insulation sleeves over the elbows **after** leakage inspection when the water-cooling is set to work (see section 10) and attach both hoses to the front ring frame..

Figure 86 - Splash guard



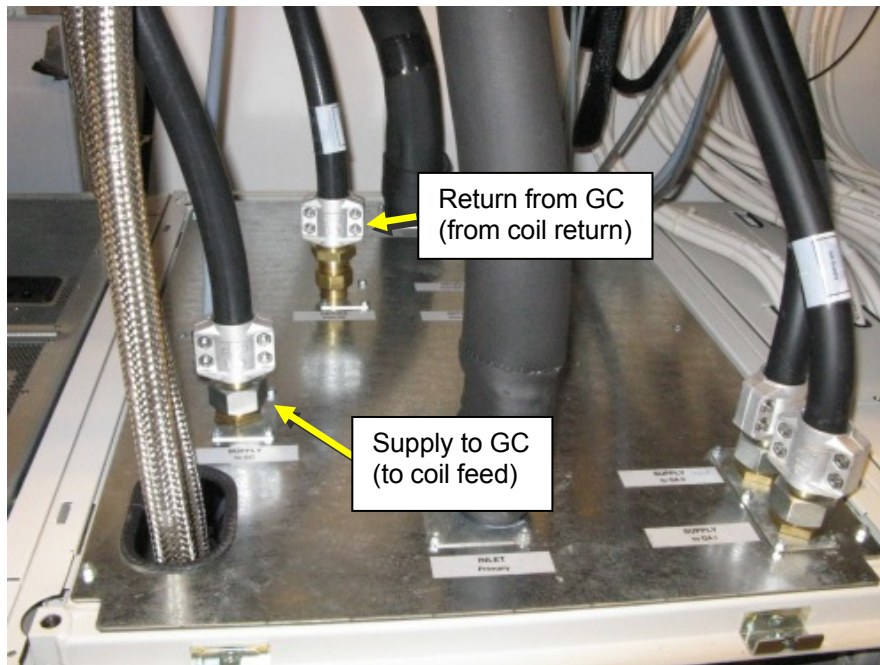
9. Route the water hoses from the feed trough in the system filter box into the technical room. See Figure 87.

Figure 87 – Water hose feed through



10. Cut the hoses to length at the LCC II side and install the connector according instructions in the coupling packaging.
11. Connect the coil supply hose to GC outlet (Figure 88).
12. Connect the return water hose to GC inlet (Figure 88).

Figure 88 - The gradient coil hoses



5.29 INSTALLATION OF THE GRADIENT AMPLIFIER HOSES

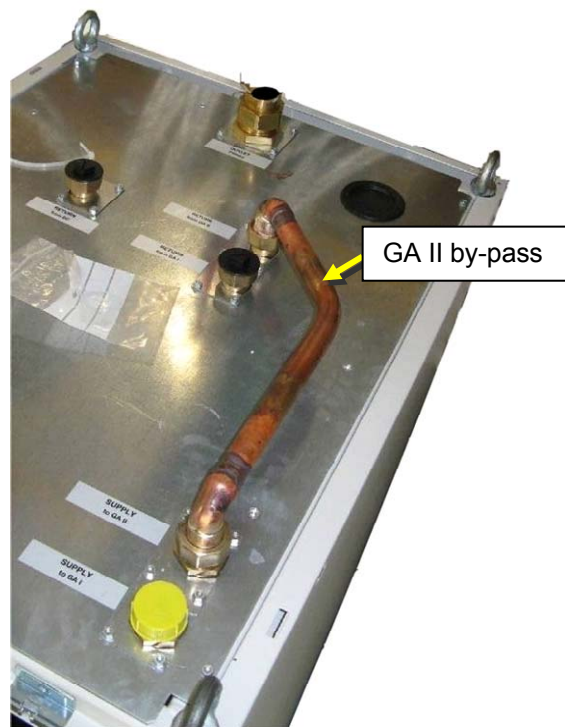
NOTE

*Gradient amplifier hoses are to be cut to length at the LCC II side.
Work from the gradient amplifier to the LCC II.*

5.29.1 Hoses to Copley 781

1. Install the copper GA II by-pass between outlet GA II and inlet GA II.

Figure 89 – GA II by-pass



2. Connect a 3/4" load hose from the gradient amplifier outlet to 'Return from GA I' of the LCC II.
3. Connect a 3/4" load hose from the gradient amplifier supply to 'Supply to GA I' of the LCC II.
4. Cut the hoses to length.
5. Install the connector according instructions in the coupling packaging.

5.29.2 Hoses to Copley 787

1. Connect a 3/4" load hose from the gradient amplifier master output to 'Return from GA I' of the LCC II.
2. Connect a 3/4" load hose from the gradient amplifier master input to 'Supply to GA I' of the LCC II.
3. Connect a 3/4" load hose from the gradient amplifier slave output to 'Return from GA II' of the LCC II.
4. Connect a 3/4" load hose from the gradient amplifier slave input to 'Supply to GA II' of the LCC II.
5. Cut the hoses to length at the LCC-II side and install the connector according to instructions in the coupling packaging.

Figure 90 – C787 Gradient amplifier hoses

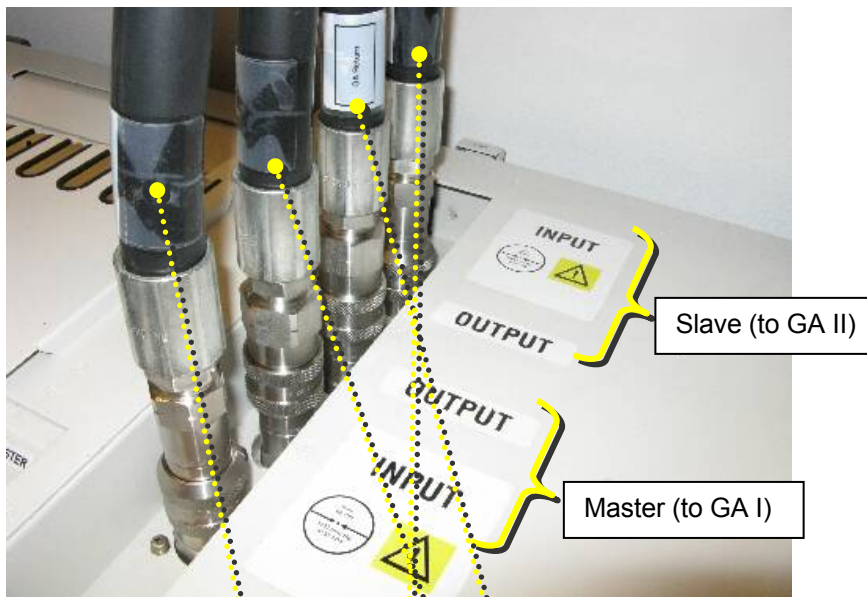
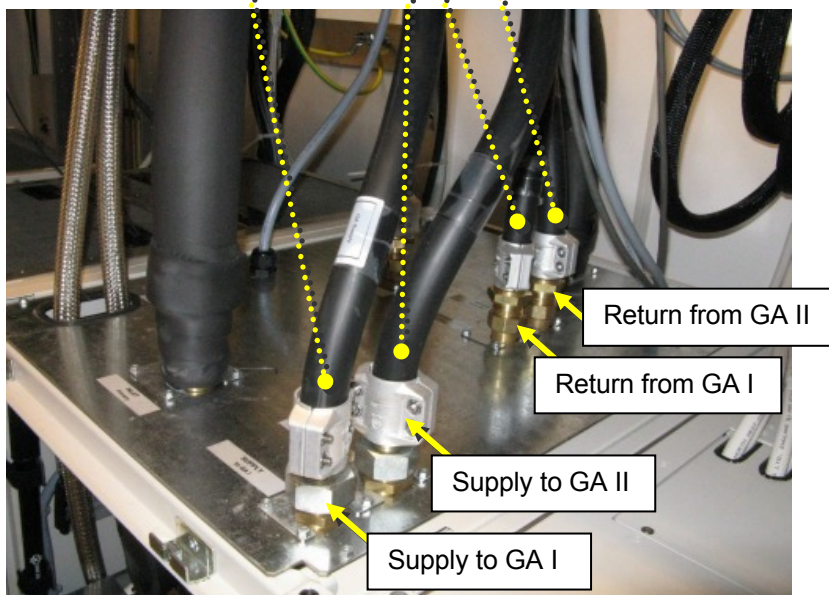


Figure 91 - LCC II gradient amplifier hoses on C787



5.30 LCCII (COMPLETE REPLACEMENT)

1. Remove the LCCII cabinet front cover.
2. Switch OFF the mains power to the LCCII in the mains distribution unit.
3. Drain the primary circuit. Refer to chapter 5.9.
4. Keep the GC shut off valves opened.
5. Drain the GC circuit. Refer to chapter 5.8.
6. Disconnect the hoses from the gradient amplifier.
7. For a Copley 78X: connect the inlet and outlet hoses together.
8. Keep the shut off valves opened.
9. Drain the GA circuit. Refer to chapter 5.8.
10. Switch off the cryo compressor
11. Disconnect HE hoses, water hoses, displacer cable and mains cable from the compressor.
12. Install the ramps for the cryo compressor.
13. Remove the compressor from the cabinet.
14. Disconnect all affected hoses.
15. Disconnect the LCC-II mains cable from the mains distribution unit and remove it from the cable duct.
16. Remove the defective LCC-II cabinet.
17. Position the new LCCII cabinet.
18. Install the LCCII mains cable and connect it to the mains distribution unit.
19. Connect all hoses to the cabinet.
20. Install the cryo compressor.
21. Connect HE hoses, water hoses, displacer cable and mains cable from the compressor.
22. Fill the primary circuit.
23. Check for leaks.
24. Fill the GC circuit. Do not forget to add inhibitor and biocide already in the final water canister, prior to the refill.
25. Fill the GA circuit. Notice that the gradient amplifier hoses are still connected together.
26. Connect the GA hoses to the gradient amplifier.
27. Switch ON the mains power to the LCC in the mains distribution unit.

6 EXPLANATIONS

6.1 LCC II FILLING PUMP

Refer to chapter 5.3.

6.2 THE ELECTRONIC BOX

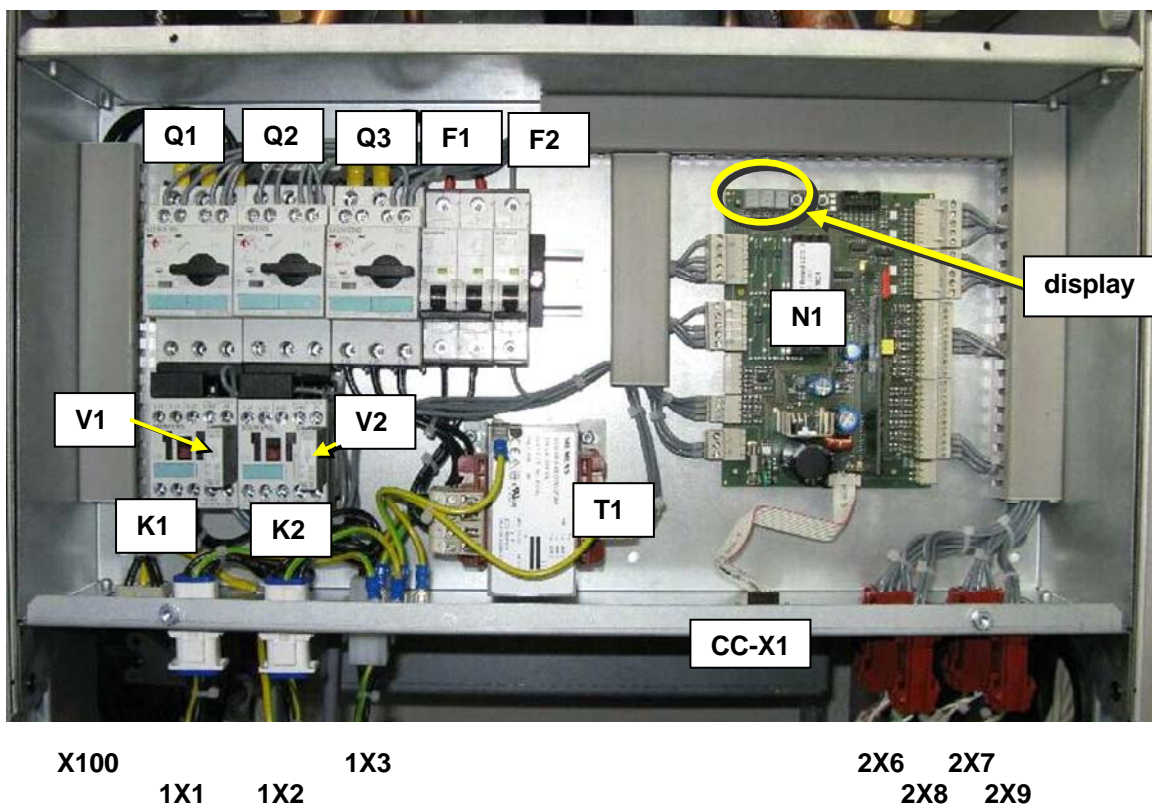
The 'electronic box' of the LCCII contains all necessary components for the automatic control- and regulation of the LCCII heat exchanger circuits. The electronic box is located behind the front panel and has its own cover, which must always be installed during normal operation because of being EMC compliant.

It contains thermal switches Q1, Q2, Q3 F1 and F2 and the PCB, which controls the both GC and GA heat exchanger circuits. See Figure 92.

Q1 = GC pump motor switch
 Q2 = GA pump motor switch
 K1 = GC pump motor contactor
 K2 = GA pump motor contactor
 V1 = GC varistor suppressor for pump motor contactor
 V2 = GA varistor suppressor for pump motor contactor
 (Varistors are used to absorb inductive spikes)

Q3 = Cryo compressor
 F1 = Primary side T1 Transformer
 F2 = Secondary side T1 transformer (24 V ~ supply voltage to the pcb)
 T1 = 24V ~transformer
 N1 = printed circuit board (pcb)

Figure 92 – Overview of the electronic box



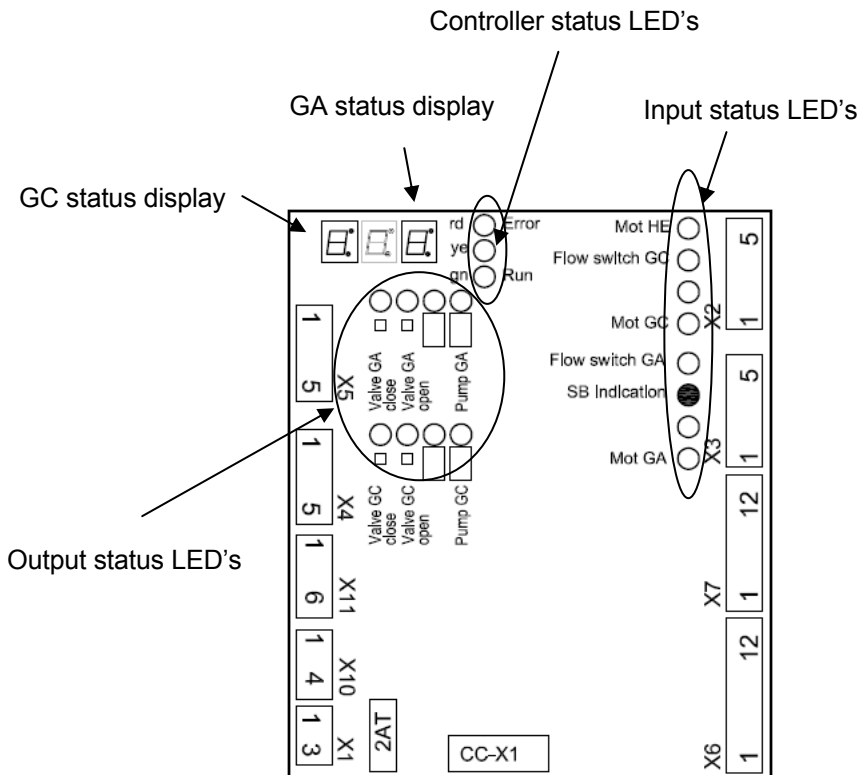
6.3 CONTROLLING

The outlet temperatures of the two secondary cooling circuits are regulated to a nominal value by means of a controller on the printed circuit board (PCB). This controller controls two 3-way valves, which are located in the secondary circuit. The temperature sensors for the secondary circuits are installed in the secondary plumbing of each circuit.

6.4 VISUAL STATUS SIGNALS

Next figure shows the visual status signals (LEDs) on the printed circuit board (PCB).

Figure 93 – The PCB



6.4.1 Controller status LED's

LED	Status	Action
Red LED	flashes	Warning
	on	Error / Interlock (check LCC info overview test)
	off	Normal operation
Yellow LED	on	Fault status
	off	Normal operation
Green LED	flashes	Controller active

6.4.2 GC / GA Status display

Display	Mode	Action
" 1 "	Initialize	Start up. Initialize the LCC: valve calibration, sensor calibration etc.
" 2 "	Normal	Normal control (Warmed up above the low temperature threshold)
" 3 "	Fault	Error: check the LCC info overview test or system logging.
" 4 "	Standby	Standby
" 5 "	Startup flow	Start-up flow (Flow switch is ignored now)
" 7 "	Temp out of range	Temperature is $15\text{ °C} < T < 20\text{ °C}$ or $30\text{ °C} < T < 40\text{ °C}$ Pumps are running, when the temperature is not within range after 30 minutes, the interlock line will switch high. As a result the gradient amplifier will be switched off.
" 9 "	Standby-warming up	When the temperature in the secondary circuit drops below 20 °C , while in standby, pumps will start running to heat up the circuit.

6.4.3 Input status LED's

LED	Action	Status
Mot HE	motor protecting switch for cryo compressor engaged	LED ON when active
Flow switch GC	Flow switch activated, there is flow the coil loop	LED ON when active
Not used	-	-
Mot GC	motor protecting switch pump GC engaged	LED ON when active
Flow switch GC	Flow switch activated, there is flow the coil loop	LED ON when active
SB indication	LCC has standby mode	LED ON always
Not used	-	-
Mot GA	motor protecting switch pump GA engaged	LED ON when active

6.4.4 Output status LED's

LED	Action	Status
Valve GA open	3-way-valve GA	LED ON if valve opens
Valve GA close	3-way-valve GA	LED ON if valve closes
Not used	-	-
Pump GA	pump GA (relay K2)	LED ON during NORMAL operation
Valve GC open	3-way-valve GC	LED ON if valve opens
Valve GC close	3-way-valve GC	LED ON if valve closes
Not used	-	-
Pump GC	pump GC (relay K1)	LED ON during NORMAL operation

The LED's will give a rough indication of the status of the LCCII and add diagnostic value while troubleshooting. More detailed information will be available through the RS 232 port, if connected to a service PC using a hyper terminal program, or through STT diagnostics.

6.5 RS 232 INTERFACE PC – LCCII

LCCII cable DGB-X11 to CC-X1 will not work with the service PC serial interface.

A 9 pin serial extension cable or cable 45221326289x (CABLE CC-X1 - PC), which is part of the measuring accessories.

Required connections in a pc to LCC cable:

Label	Serial port PC	CC-X1
Connectors	D-Shell, 9 positions	D-Shell, 9 positions
Terminations	Socket (Female)	Pin (Male)
Connections	Position 1 GND	Position 1 GND
	Position 2 TX	Position 2 RX
	Position 3 RX	Position 3 TX
	Position 5 GND	Position 5 GND
	Position 8 FAULTN	Position 8 FAULTN
	Position 9 FAULT-ENABLE	Position 9 FAULT-ENABLE
	housing	housing (cable screen)

6.6 RS 232 INTERFACE IGCI – LCCII

LCCII cable DGB-X11 to CC-X1 (This cable will not work with the service PC serial interface)

Label	Serial port IGCI	CC-X1
Connectors	D-Shell, 9 positions	D-Shell, 9 positions
Terminations	Socket (male)	Pin (Male)
Connections	Position 1 GND	Position 1 GND
	Position 2 TX	Position 3 TX
	Position 3 RX	Position 2 RX
	Position 5 GND	Position 5 GND
	Position 8 FAULTN	Position 8 FAULTN
	Position 1-9 FAULT-ENABLE	
		Position 1-9 FAULT-ENABLE (no function)
	housing	housing (cable screen)

TX / RX is RS232 communication is crossed (2-3, 3-2), in this case, between the IGCI I/O board and LCCII. Fault-enable, is a through connection from pin 1 to 9. The through connection at the IGCI side will enable the LCC Faultn communication (The through connection 1 – 9 at the LCCII side is not used.)

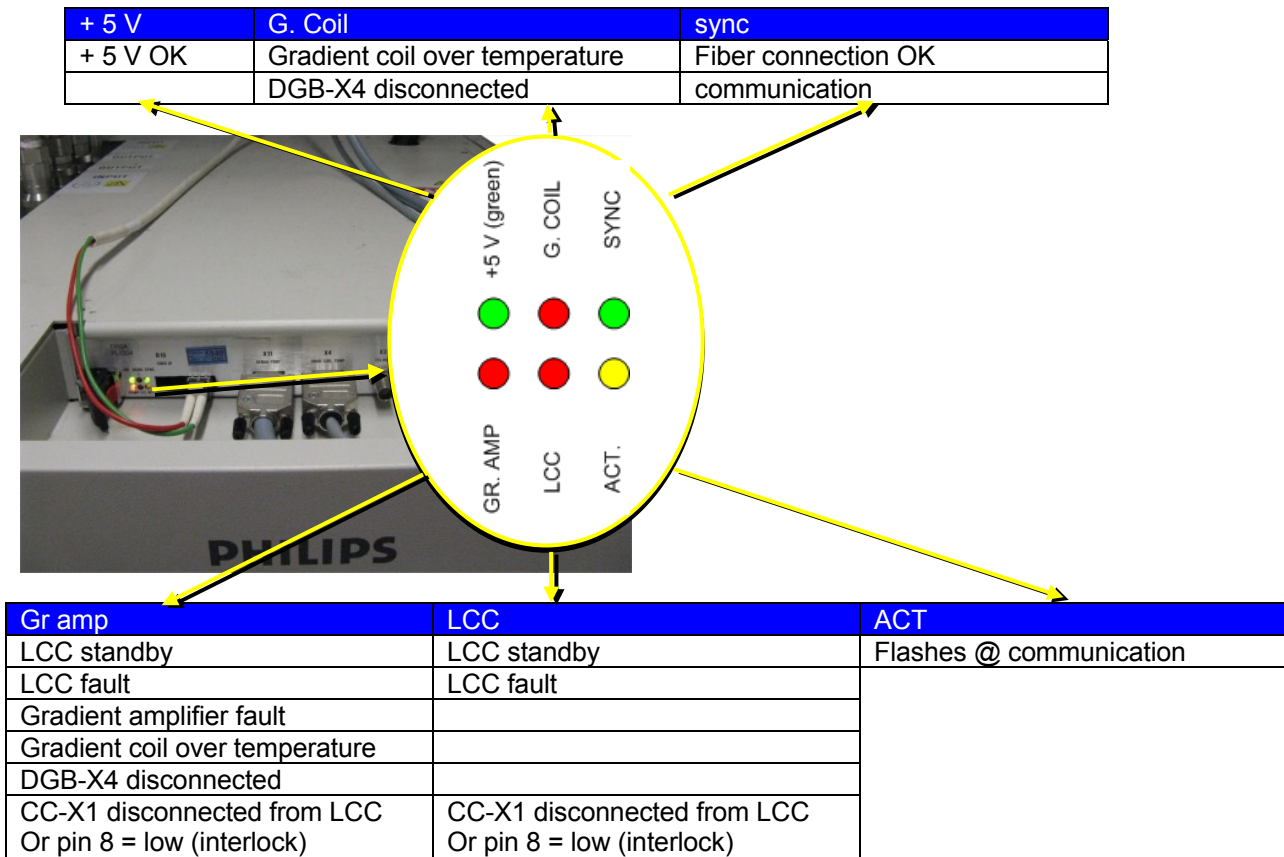
Faultn is the, negative active, fault line for the LCC towards the IGCI I/O. As soon as this line is pulled low, or connection is interrupted between the LCCII pcb and IGCI, the gradient amplifier high voltage power supply output power will be disabled. As a result the axis amplifiers are switched off.

6.7 THE IGCI LED'S (VISSIBLE AT THE TOP GRADIENT AMPLIFIER)

When the red LCC LED is lit, the IGCI has detected an interlock from the LCC2. Either the LCC2 is switched to stand-by (LCC display status 4 4) or the LCC2 has a failure (LCC display status 3 3). As a result, the high voltage output of the gradient amplifier power supply will be disabled and the gradient amplifier does not send a 'gradient amplifier ok signal' to the IGCI. Therefore, the red GR. AMP LED will always be lit when the red LCC LED is lit.

When the red G. COIL LED is lit because of a tripped clixon in the gradient coil or a disconnected cable, the gradient amplifier will be disabled and as a result the red GR. AMP LED will be lit.

Figure 94 – IGCI



6.8 GENERAL RS 232 PROTOCOL INFORMATION

- There will be no communication placed on the RS232 port other than requested by the host (interlock status excluded)
- Each command shall end with a CR.
- The command will be echoed in defined format.
- The echo shall end with a CR followed by a LF
- Each reply by the LCC shall be separated by a (CR).
- Replies do not have a fixed length.
- In case of a wrong command received by LCC, “wrong input!” is returned
- In case of a range error received by LCC, “RANGE ERROR” is returned
- Each reply shall start with an “>” as implemented

6.9 INTERLOCK ERROR STATUS

Under the next listed conditions, applicable for either one or both secondary circuits, the LCCII controller circuit will generate an interlock error on the RS 232 port.

- Low flow (secondary loops)
- temperature sensor defect
- Motor switch tripped
- Filling pressure sensor defect
- Filling pressure sensor <0.3 bar

Under all these conditions an interlock error will be generated and the cooling circuits (both GA and GC) will be shut down. As soon as the conditions are restored the LCC will automatically get into normal operating mode.

6.10 STANDBY BEHAVIOR

After each scan, a standby signal is sent to the LCCII. This signal starts a timer at the LCCII printed circuit board, which switches the LCCII to standby after 90 minutes of no scanning. The standby mode will pull pin 8 of the serial interface low. As a result the GCI/IGCI will switch off the gradient amplifier. If the standby command is given while the LCCII has a 'temperature out of range' the delay time will be extended with 30 minutes.

7 FAULT FINDING

NOTE

*When Cable CC-X1 DGB-X11 is disconnected at the ICGI / gradient amplifier side:
A scan attempt or starting a test will result in a fault. In the log file next line will be visible:
CDAS <DEVICE>: LCC Device has a hardware Error: No communication.*

*Cable CC-X1 DGB-X11 is disconnected at the LCC side, while connected at the ICGI / gradient amplifier side:
Gradient axis amplifiers do not power up.*

CAUTION

*Output signals of the temperature sensors and pressure sensors cannot be shorted for test purpose.
Shorting these signals will result in a burned PCB in the electronics box within a short time.*

7.1 LCC INFO OVERVIEW TEST

1. Logon: **MRService** + password (Case sensitive!)
2. Select: **Start → MR Applications → Scan Applications → STT application**
3. Select: **Diagnostic procedures**
4. Select: **Gradient**
5. Select: **LCC**
6. Select: **LCC Info overview test**
7. The test shows a list of results as shown in Figure 9. In this example the primary flow is out of spec.

Figure 95 - LCC Info overview test

Overview of LCC parameters

Result: Error

Flag	Parameter Name	Actual Value	Nominal Value	Spec Value
	LCC: Board Access	Passed	Passed	Passed
	LCC: Software version/layout	0.22		
	LCC: Serial number	7		
	LCC: Primary Temperature T1 [D]	13.1	10.0	[5.0 : 15.0]
***	LCC: Primary Flow [liter/min]	24	70	[40 : 150]
	LCC: GA Valve Position [Sec]	10.7	120.0	
	LCC: GA Temperature [DegC]	25.6	24.5	[18.0 : 32.0]
	LCC: GA Setpoint Temp [DegC]	25.0	25.0	[20.0 : 30.0]
	LCC: GA Valve Gain [%]	8.0	5.0	
	LCC: GA Valve Int Time [Sec]	30.0	30.0	
	C: GA Pump Status	ON	ON	ON
	C: GA Pump Operating hours	455.0		>0.0
	LCC: GA Filling Pressure [Bar]	2.3	1.2	[-3.0 : 9.9]
	LCC: GC Valve Position [Sec]	6.4	120.0	
	LCC: GC Temperature [DegC]	25.3	24.5	[18.0 : 32.0]
	LCC: GC Setpoint Temp [DegC]	25.0	25.0	[20.0 : 30.0]
	LCC: GC Valve Gain [%]	8.0	5.0	
	LCC: GC Valve Int Time [Sec]	50.0	50.0	
	LCC: GC Pump Status	ON	ON	ON
	LCC: GC Pump Operating hours	455.0		>0.0
	LCC: GC Filling Pressure [Bar]	2.2	1.2	[-3.0 : 9.9]

Cooling water inflow out of spec

7.2 LCC FAULTS

Fault	Malfunction/Cause	Remedy
No communication with LCC	Cable CC-X1 DGB-X11	Connect cable CC-X1 DGB-X11
	Bad contact at CC-X1, metric and USC threaded connection. (gradient axis amplifiers do not start up)	Connect cable CC-X1 DGB-X11 the other way around. The cable is one to one, but one side has metric screws and the other side has UNC screws. UNC screw must be at LCC side.
Low filling pressure	Low pressure	Check for leaks, pressurize the circuit.
No primary flow	Chiller off or,	Switch on the chiller
	Primary input and out put hose wrong connected.	Correct primary water connection.
	Inlet filter blocked	Clean filter
F3, thermal switch for cryo compressor trips after some time	One phase is not connected	Check connection in LCCII and at the cryo compressor
Secondary temperature increases over longer time (months)	Heat exchanger can be corroded because no inhibitor and biocide were added to the cooling water.	Replace the heat exchanger
Secondary flow too low	Pump is running in wrong direction.	Check phase rotation.
Gradient amplifier does not start up	Fault line pin 8 in serial cable is open between IGCI and LCC.	Check at connector CC-X1 or resistor in ribbon cable.

7.3 CONNECTING A SERVICE PC (LAPTOP)

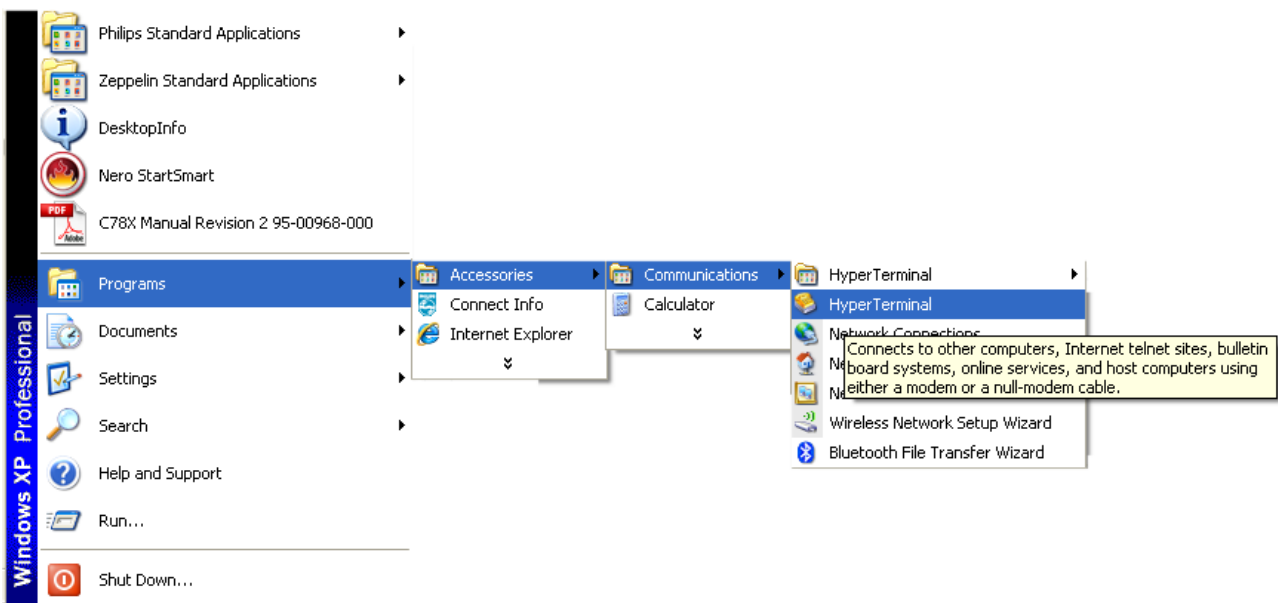
Connector type: 9p D connector (female)
 Protocol: ASCII
 Baud rate: 9600
 Parity check: (Parity) None, (Data bits) 8, (Stop bits) 1
 Digital logic: Control: ±5V RS232 (EIA/TIA-232), Status: ±5V RS232 (EIA/TIA-232).

LCCII cable DGB-X11 to CC-X1 will not work with the service PC serial interface.
 A 9 pin serial extension cable or cable 45221326289x (CABLE CC-X1 - PC), which is part of the measuring accessories.

Label	Serial port PC	CC-X1
Connectors	D-Shell, 9 positions	D-Shell, 9 positions
Terminations	Socket (Female)	Pin (Male)
Connections	Position 1 GND	Position 1 GND
	Position 2 TX	Position 2 TX
	Position 3 RX	Position 3 RX
	Position 5 GND	Position 5 GND
	Position 8 FAULTN	Position 8 FAULTN

1. Disconnect CC-X1 from the LCCII electronic box.
2. Connect the serial extension cable between the service PC and CC-X1 of the LCCII electronics box.
3. Switch on the LCCII if not yet done.
4. Startup hyper terminal.

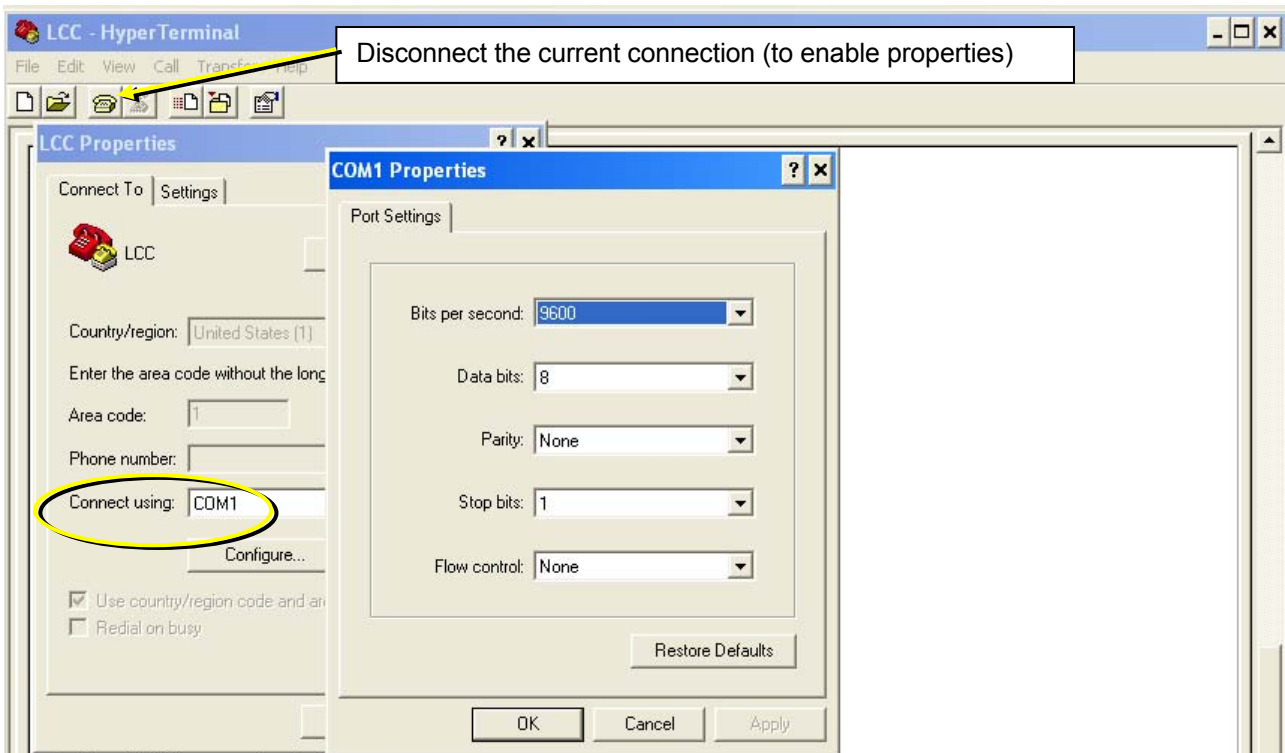
Figure 96 - hyper terminal



5. Disconnect the current connection (to enable properties).
6. Select file / properties.
7. Connect using: Select com1.
8. Select configure.

9. Enter the port settings as in Figure 97.

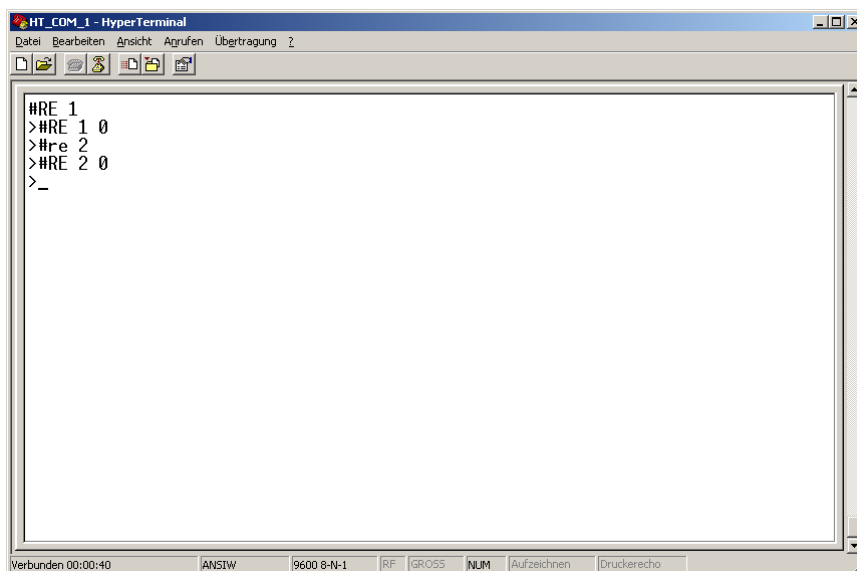
Figure 97 - hyper terminal setup



10. Enter #RE 1 read back the error for GC circuit. 0 means, that there is no error.

11. Enter #RE 2 read back the error for GA circuit. 0 means, that there is no error.

Figure 98 - hyper terminal screen



7.4 ADDITIONAL ‘HYPERTERMINAL’ COMMANDS

Description	Format	Reply
Get primary temperature	#PT<space>1	#PT<space>1<space>xxx xxx = example 250 = 25.0 °C
Get primary flow	#PF<space>1	#PF<space>1<space>xx xx= example 70 = 70 l/h
Get GC temperature	#RT<space>1	#RT<space>1<space>xxx xxx = example 250 = 25.0 °C
Get GA temperature	#RT<space>2	#RT<space>2<space>xxx xxx = example 250 = 25.0 °C
Get GC set point	#RS<space>1	#RS<space>1<space>xxx xxx = example 250 = 25.0 °C
Get GA set point	#RS<space>2	#RS<space>2<space>xxx xxx = example 250 = 25.0 °C
Get GC filling pressure	#RF<space>1	#RF<space>1<space>xx xx = example 15 = 1.5 bar
Get GA filling pressure	#RF<space>2	#RF<space>2<space>xx xx = example 15 = 1.5 bar
Get GC digital signals	#RD<space>1	#RD<space>1<space>xxxx<space>yyyy xxxx yyyy 1=ok, 0=nok 1234 5678 1=Q1 pump switch 2= n.a. 3=flow switch 4=Q3 HE compressor switch 5=pump running 6=n.a. 7=increasing cooling capacity 8=decreasing cooling capacity
Description	Format	Reply
Get GA digital signals	#RD<space>2	#RD<space>2<space>xxxx<space>yyyy xxxx yyyy 1=ok, 0=nok 1234 5678 1=Q2 pump switch 2= n.a. 3= stand by supported 4= flow switch 5=pump running 6=n.a. 7=increasing cooling capacity 8=decreasing cooling capacity
Normal control	#NC	#NC (LCCII starts and the standby timer is stopped)
Standby	#SB<space>xxx xxx = LCCII goes standby after xxx minutes + 5 seconds #SB 0 switches immediately	#SB<space>xxx
Get error	#RE<space>y Y= 1 for GC, 2 for GA	#RE<space>y<space>xxx xxx is the error code, refer to chapters: 7.5, 0 or 7.7

7.5 ERROR CODES FOR PRIMARY CIRCUIT

Refer to the 'Get error' command in chapter 7.4.

Error Code	Malfunction/Cause	Remedy
10	Primary Flow is lower the 60l/min (B10) <ul style="list-style-type: none"> Water flow on primary circuit is too low Shut-off valve on primary side is closed Strainer is contaminated Sensor is contaminated Sensor fault 	Check primary water connection (house water) Check shut-off valve Clean strainer Clean sensor B10 Replace sensor B10
12	Primary temperature sensor is defect (B10) <ul style="list-style-type: none"> Loose electrical connection to temperature sensor Sensor fault Printed circuit board (PCB) is defect Check voltages on PCB X10 Pin 4-3 : +5V Pin 1-3 : +0.5..+3.5V	Check electrical connection on sensor B10 Check connection 2X6 on electronic box Check connection X10 on PCB Replace sensor B10 Replace PCB
32	Primary flow sensor is defect (B10) <ul style="list-style-type: none"> Loose electrical connection to flow sensor Sensor fault Printed circuit board (PCB) is defect Check voltages on PCB X10 Pin 4-3 : +5V Pin 2-3 : +0.35..+3.5V	Check electrical connection on sensor B10 Check connection 2X6 on electronic box Check connection X10 on PCB Replace sensor B10 Replace PCB

7.6 ERROR CODES FOR GC CIRCUIT

Refer to the 'Get error' command in chapter 7.4.

Error Code	Malfunction/Cause	Remedy
101	Motor switch GC circuit tripped (Q1) <ul style="list-style-type: none"> Pump motor overload due to mechanical sluggishness Motor overload due to phase failure 	Check pump, replace if necessary Move motor protecting switch Q1 to position -1- Correct phase failure, Move motor protecting switch Q1 to position -1-
103	Low Flow GC circuit (B5) <ul style="list-style-type: none"> Cooling water volume flow in GC circuit is too low (<10l/min) GC pump not running Loose electrical connection to flow sensor Sensor fault 	Check cooling water circuit in GC circuit Check shut-off valve Perform functional check of GC pump Check connector 2X6 as well as circuit to flow sensor B5 Check sensor B5
108	Filling pressure GC circuit < 0.3bar (B3) <ul style="list-style-type: none"> Pressure in GC circuit is lower than 0.3 bar Leakage in GC circuit No fluid in GC circuit 	Check pressure in GC circuit, refill fluid in GC circuit Check that GC circuit is free from leakage Check if GC circuit is filled with fluid

Error Code	Malfunction/Cause	Remedy
	<ul style="list-style-type: none"> Zero charge pressure in expansion vessel is too low 	Check pressure in expansion vessel
109	<p>Pressure GC circuit < 0.7bar (B3)</p> <ul style="list-style-type: none"> Pressure in GC circuit is lower than 0.7 bar Leakage in GC circuit Zero charge pressure in expansion vessel is too low 	<p>Check pressure in GC circuit, refill fluid in GC circuit</p> <p>Check that GC circuit is free from leakage</p> <p>Check pressure in expansion vessel</p>
110	<p>Temperature GC circuit < lower trip point [default: 20.0°C]</p> <ul style="list-style-type: none"> Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set 	<p>Check control valve</p> <p>Check electrical connection, check connector 2X8</p> <p>Set tolerance limits</p>
111	<p>Temperature GC circuit > higher trip point [default: 30.0°C]</p> <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set Gradient Coil power is too high 	<p>Check primary flow</p> <p>Check primary temperature</p> <p>Check control valve</p> <p>Check electrical connection, check connector 2X8</p> <p>Set tolerance limits</p> <p>Check gradient coil power</p>
112	<p>Temperature sensor GC circuit defect (B1)</p> <ul style="list-style-type: none"> Sensor fault Loose electrical connection to temperature sensor 	<p>Check sensor B1</p> <p>Replace sensor B1</p> <p>Check electrical connection on sensor B1</p> <p>Check connection 2X6 on electronic box</p> <p>Check connection X6 on PCB</p>
113	<p>Temperature GC circuit < 15°C</p> <ul style="list-style-type: none"> Control valve doesn't work Control valve has no electrical connection Pump is not running 	<p>Check control valve</p> <p>Check electrical connection, check connector 2X8</p> <p>Perform functional check of GC pump</p>
114	<p>Temperature GC circuit > 40°C</p> <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Gradient Coil power is too high 	<p>Check primary flow (strainer)</p> <p>Check primary temperature</p> <p>Check control valve</p> <p>Check electrical connection, check connector 2X8</p> <p>Check gradient coil power</p>
115	<p>Temperature GC circuit > higher trip point [default: 30.0°C] (t > 30min)</p> <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set Gradient Coil power is too high 	<p>Check primary flow (strainer)</p> <p>Check primary temperature</p> <p>Check control valve</p> <p>Check electrical connection, check connector 2X8</p> <p>Set tolerance limits</p> <p>Check gradient coil power</p>

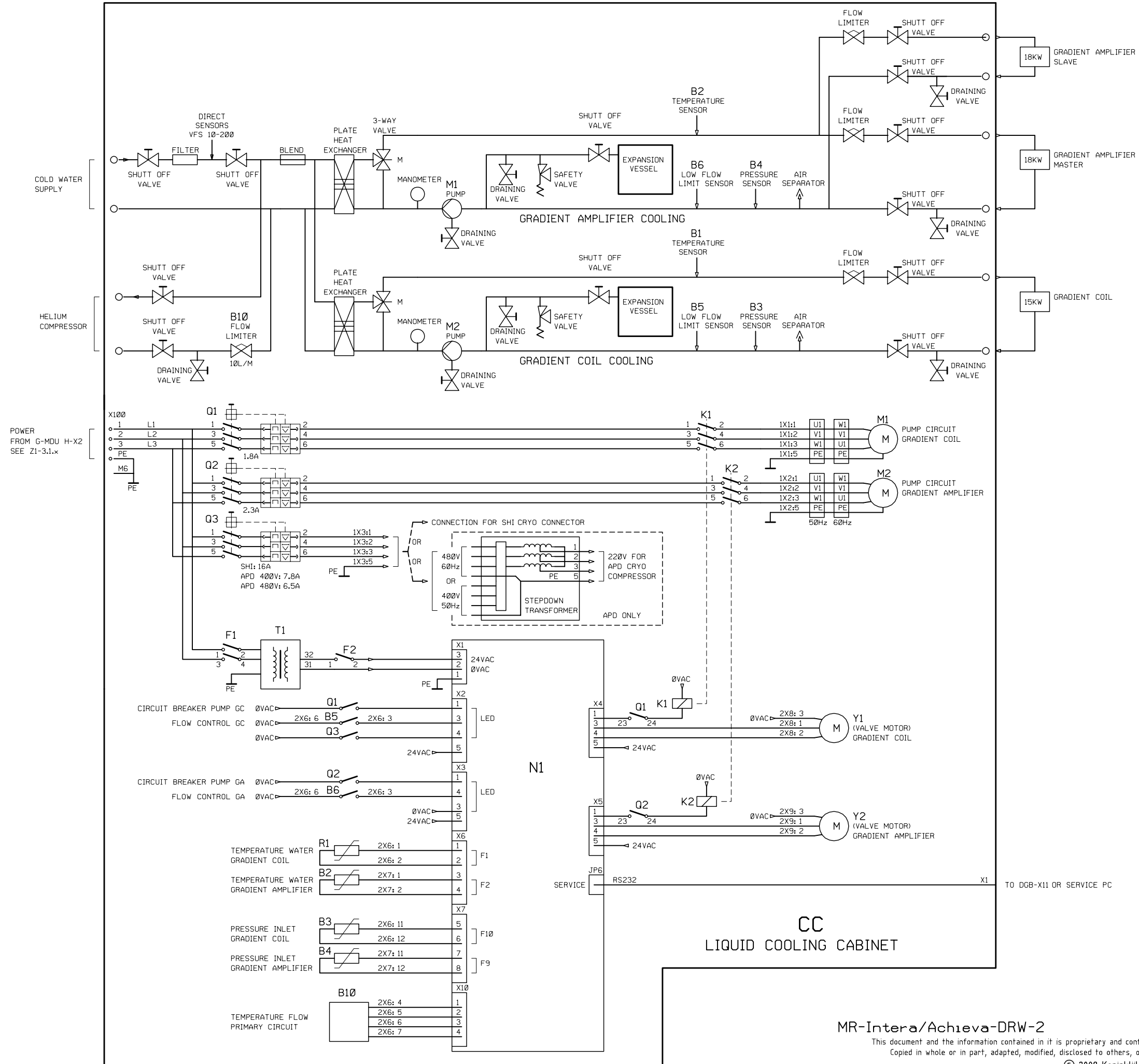
Error Code	Malfunction/Cause	Remedy
116	Temperature GC circuit < lower trip point [default: 20.0°C] (t > 30min) <ul style="list-style-type: none"> • Control valve doesn't work • Control valve has no electrical connection • Tolerance limits incorrectly set 	Check control valve Check electrical connection, check connector 2X8 Set tolerance limits
121	Filling pressure GC defect (B3) <ul style="list-style-type: none"> • Sensor fault • Loose electrical connection to pressure sensor 	Check sensor B3 Replace sensor B3 Check electrical connection on sensor B3 Check connection 2X6 on electronic box Check connection X7 on PCB

7.7 ERROR CODES FOR GA CIRCUIT

Refer to the 'Get error' command in chapter 7.4.

Error Code	Malfunction/Cause	Remedy
201	Motor switch GA circuit tripped (Q2) <ul style="list-style-type: none"> Pump motor overload due to mechanical sluggishness Motor overload due to phase failure 	Check pump, replace if necessary Move motor protecting switch Q2 to position -1- Correct phase failure, Move motor protecting switch Q2 to position -1-
203	Low Flow GA circuit (B6) <ul style="list-style-type: none"> Cooling water volume flow in GA circuit is too low (<40l/min) GA pump not running Loose electrical connection to flow sensor Sensor fault 	Check cooling water circuit in GA circuit Check shut-off valve Perform functional check of GA pump Check connector 2X7 as well as circuit to flow sensor B6 Check sensor B6
208	Pressure GA circuit < 0.3bar (B4) <ul style="list-style-type: none"> Pressure in GA circuit is lower than 0.3 bar Leakage in GA circuit No fluid in GA circuit Zero charge pressure in expansion vessel is too low 	Check pressure in GA circuit, refill fluid in GA circuit Check that GA circuit is free from leakage Check if GA circuit is filled with fluid Check pressure in expansion vessel
209	Pressure GA circuit < 0.7bar (B4) <ul style="list-style-type: none"> Pressure in GA circuit is lower than 0.7 bar Leakage in GA circuit Zero charge pressure in expansion vessel is too low 	Check pressure in GA circuit, refill fluid in GA circuit Check that GA circuit is free from leakage Check pressure in expansion vessel
210	Temperature GA circuit < lower trip point [default: 20.0°C] <ul style="list-style-type: none"> Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set 	Check control valve Check electrical connection, check connector 2X9 Set tolerance limits
211	Temperature GA circuit > higher trip point [default: 30.0°C] <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set Gradient Coil power is too high 	Check primary flow Check primary temperature Check control valve Check electrical connection, check connector 2X9 Set tolerance limits Check gradient coil power
212	Temperature sensor GA circuit defect (B2) <ul style="list-style-type: none"> Sensor fault Loose electrical connection to temperature sensor 	Check sensor B2 Replace sensor B2 Check electrical connection on sensor B2 Check connection 2X7 on electronic box Check connection X6 on PCB
213	Temperature GA circuit < 15°C <ul style="list-style-type: none"> Control valve doesn't work 	Check control valve

Error Code	Malfunction/Cause	Remedy
	<ul style="list-style-type: none"> Control valve has no electrical connection Pump is not running 	<p>Check electrical connection, check connector 2X9</p> <p>Perform functional check of GA pump</p>
214	<p>Temperature GA circuit > 40°C</p> <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Gradient Coil power is too high 	<p>Check primary flow (strainer)</p> <p>Check primary temperature</p> <p>Check control valve</p> <p>Check electrical connection, check connector 2X9</p> <p>Check gradient coil power</p>
215	<p>Temperature GA circuit > higher trip point [default: 30.0°C] (t > 30min)</p> <ul style="list-style-type: none"> Insufficient flow on primary circuit Temperature of primary circuit is too high Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set Gradient Coil power is too high 	<p>Check primary flow (strainer)</p> <p>Check primary temperature</p> <p>Check control valve</p> <p>Check electrical connection, check connector 2X9</p> <p>Set tolerance limits</p> <p>Check gradient coil power</p>
216	<p>Temperature GA circuit < lower trip point [default: 20.0°C] (t > 30min)</p> <ul style="list-style-type: none"> Control valve doesn't work Control valve has no electrical connection Tolerance limits incorrectly set 	<p>Check control valve</p> <p>Check electrical connection, check connector 2X9</p> <p>Set tolerance limits</p>
221	<p>Filling pressure GA defect (B4)</p> <ul style="list-style-type: none"> Sensor fault Loose electrical connection to pressure sensor 	<p>Check sensor B4</p> <p>Replace sensor B4</p> <p>Check electrical connection on sensor B4</p> <p>Check connection 2X7 on electronic box</p> <p>Check connection X7 on PCB</p>



PRINCIPLE DIAGRAM
LIQUID COOLING CABINET II
APD/SHI VERSION