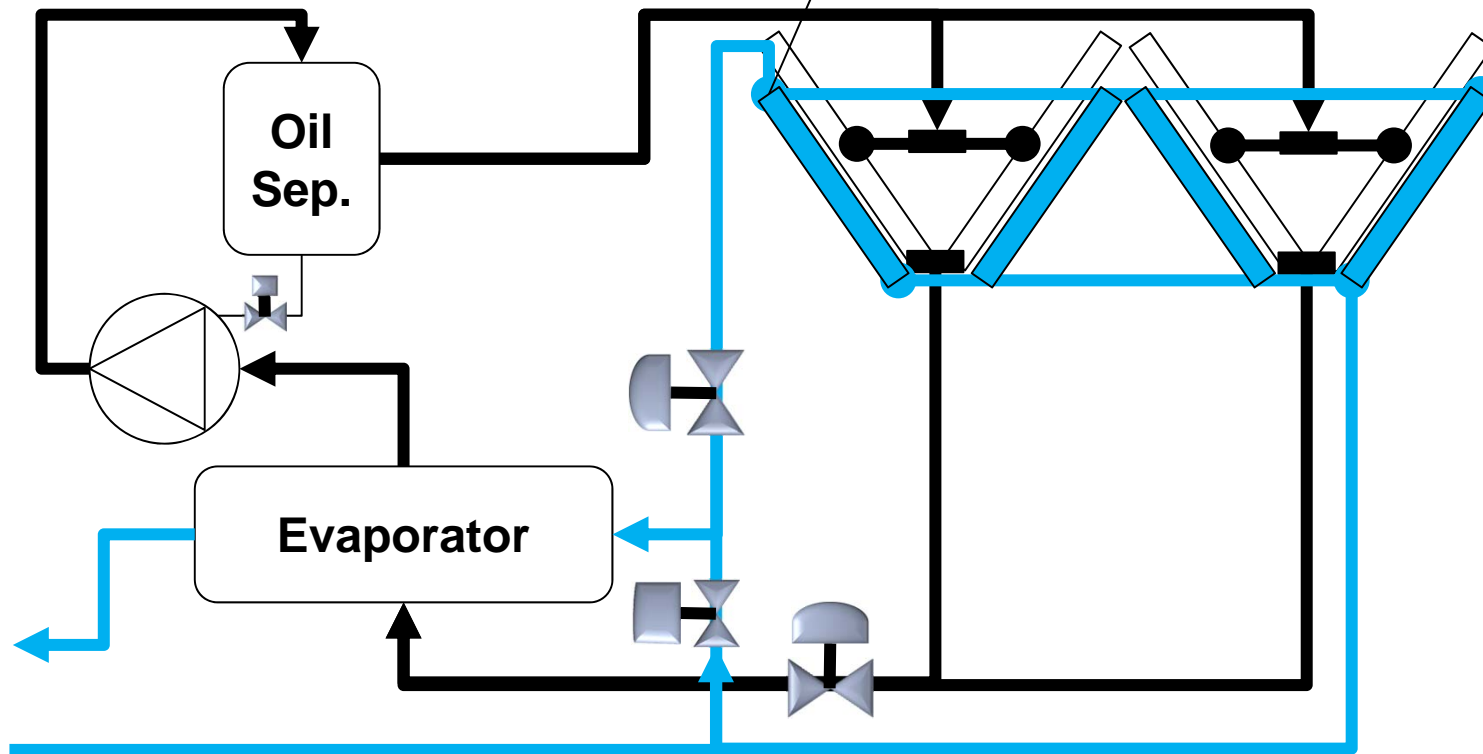
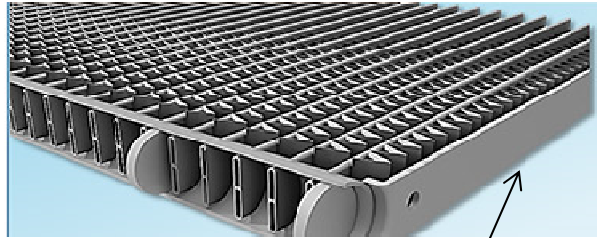


Free cooling on RTAF Chiller

Integrated option

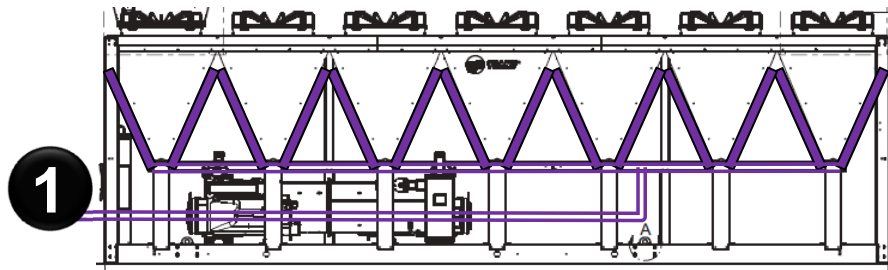
Water based free cooling principle.

- Use full aluminum (car radiator based) flat channel dry cooler exchangers.
- Modulate 3 way valve to reach required free cooling capacity.
- Need low air pressure drop coil to avoid upgrade of fans.



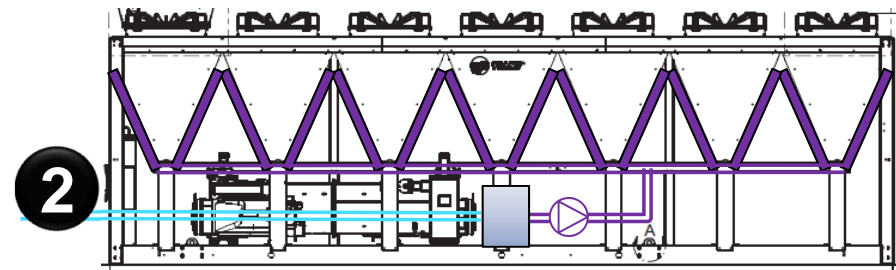
Technical proposition

- Alternative 1 : no change on condenser fan = lower EER, but no fan impact on cost, almost no impact on sound level



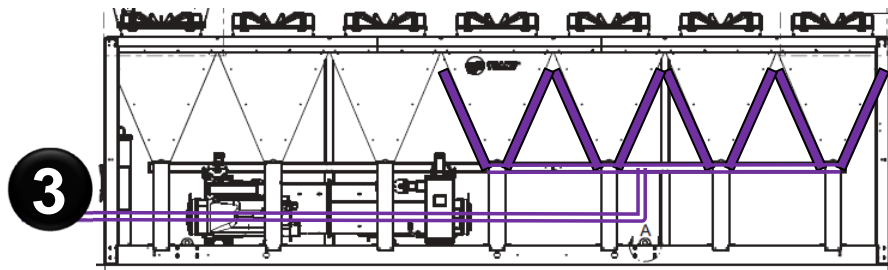
Total Free cooling

Direct free cooling version (With glycol on customer loop)



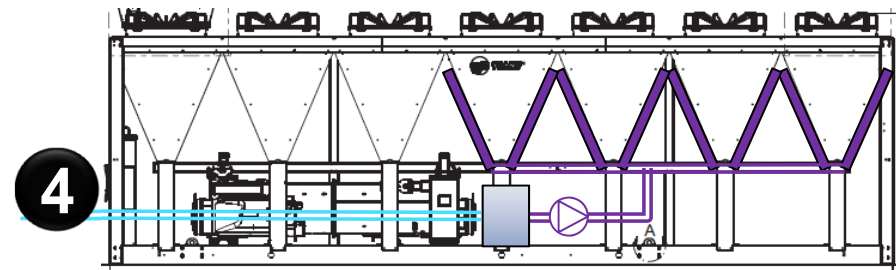
Total Free cooling

Glycol Free version (With water on customer loop)



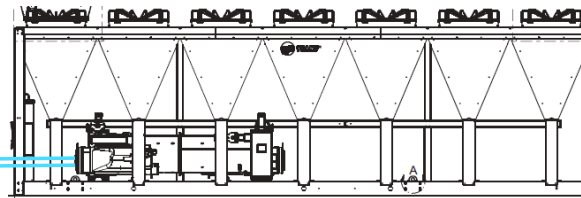
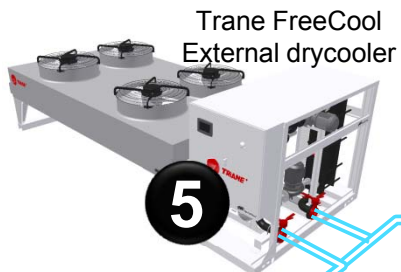
Partial Free cooling

Direct free cooling version (With glycol on customer loop)



Partial Free cooling

Glycol Free version (With water on customer loop)

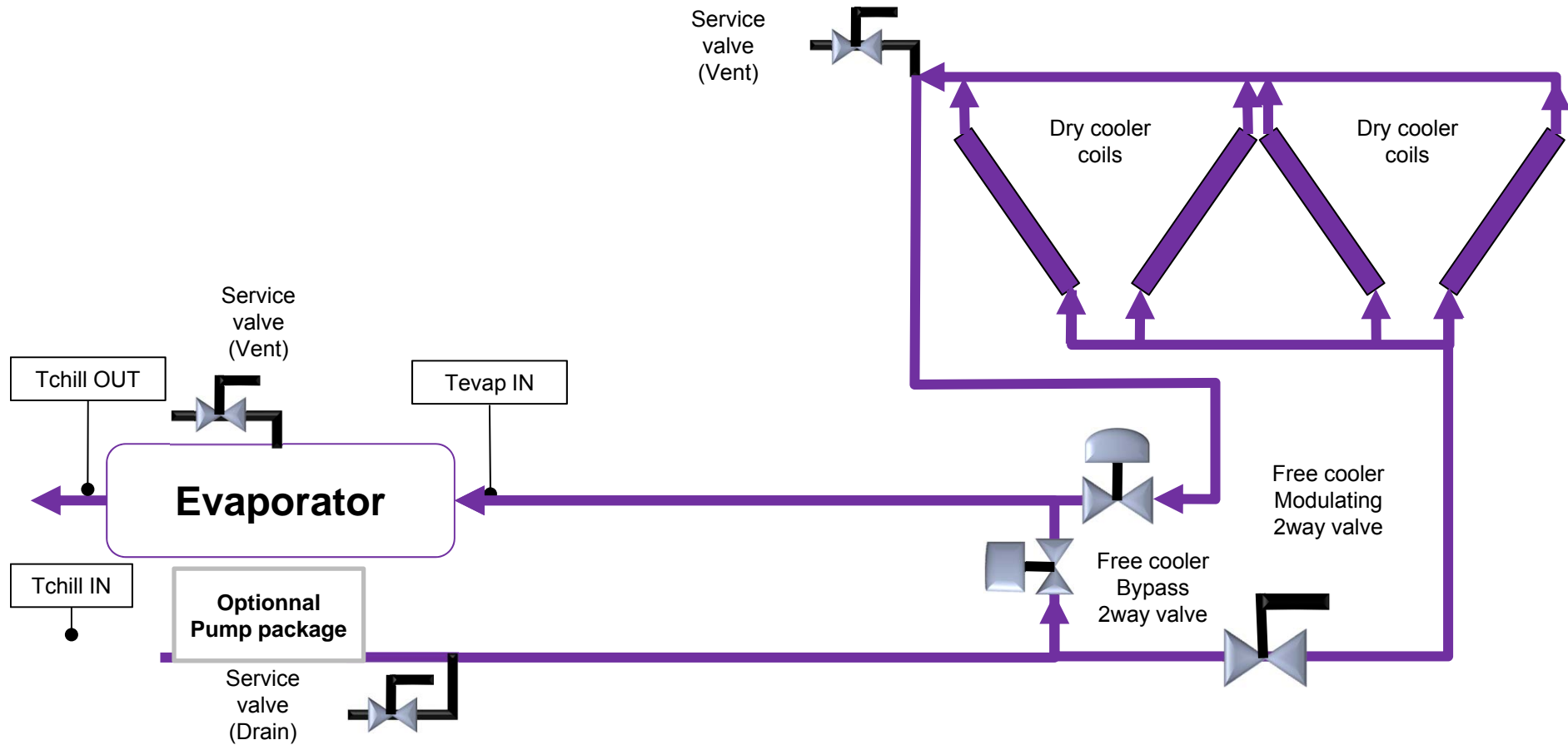


External Dry cooler – Standard RTAF

With or without glycol on customer loop

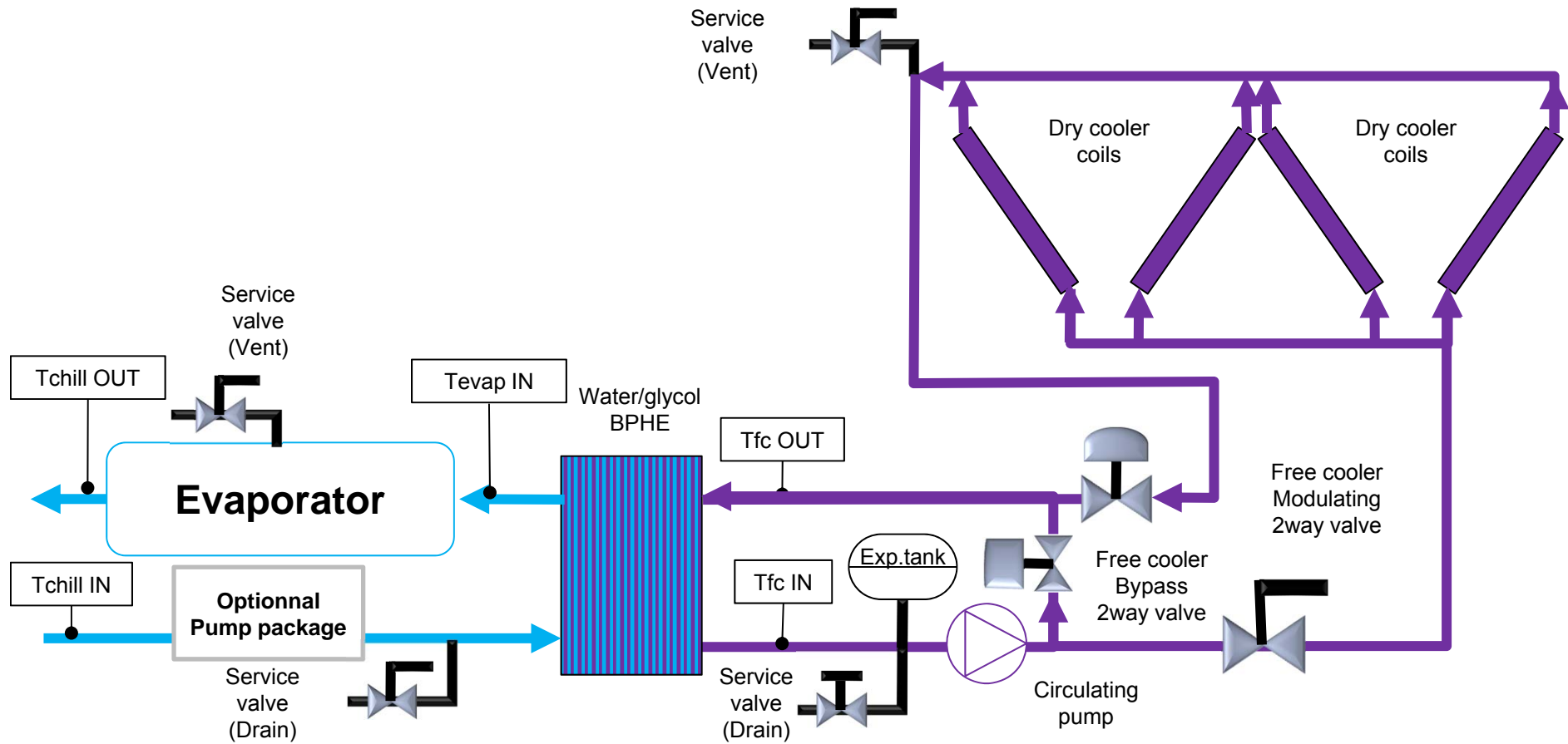
Flow chart - Free cooling Direct free cooling version (With glycol on customer loop)

1 3



Flow chart - Free cooling Glycol Free version (With water on customer loop)

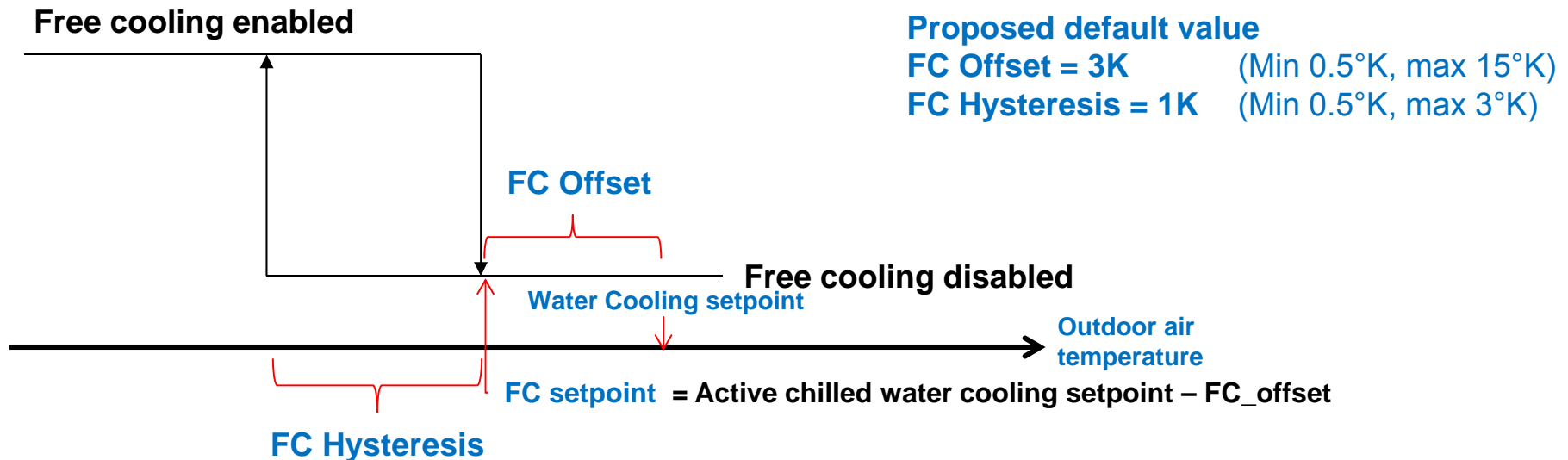
2 4



Free cooling enabling condition

Condition to get free cooling active :

- Unit is in active cooling mode.
- Outdoor temperature shall be low enough. Cf. diagram here below



The free cooling function is enabled when outdoor air temperature is below (Active chilled water cooling set point minus FC_offset).

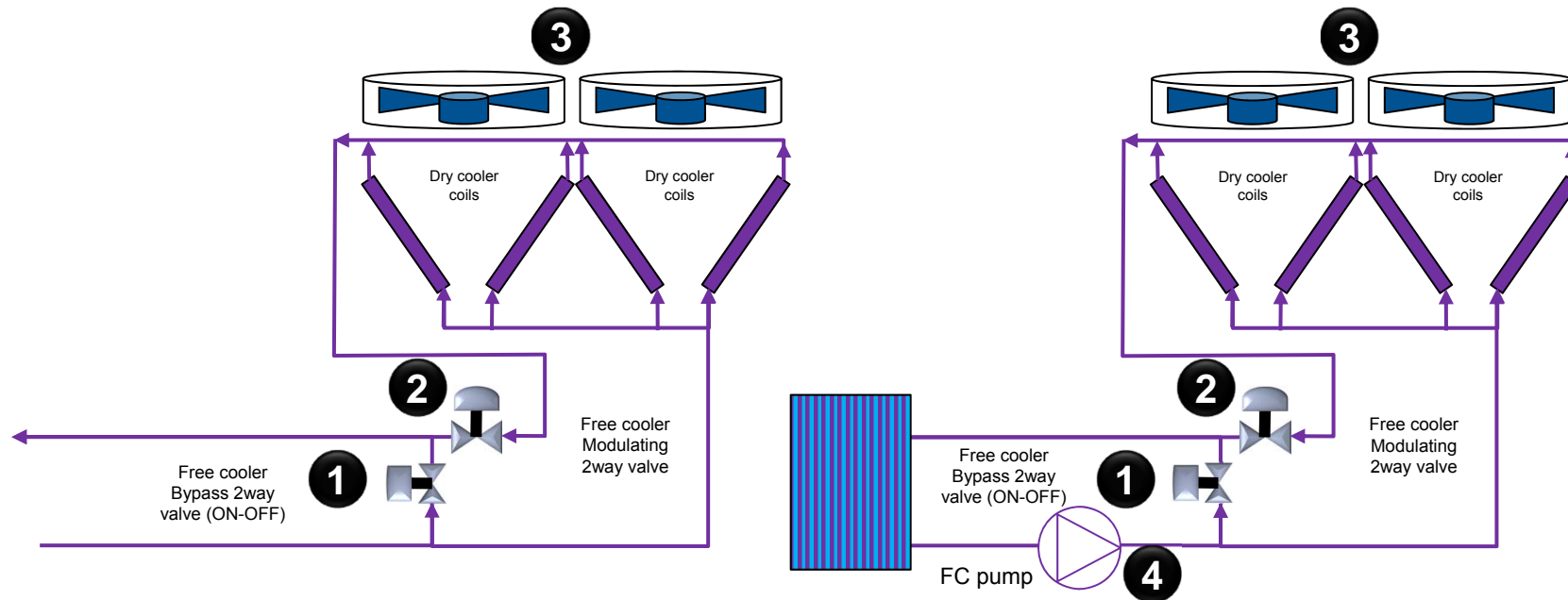
An hysteresis shall be applied to avoid short cycling of FC enable logic.

FC offset is the parameter adjusted by user to make free cooling active.

Free cooling becomes the 1st stage of cooling, whatever the compressor sequence selected:

- If free cooling is enabled while compressor is running, then unload command of the algorithm shall apply to running compressor . In case of load command, then free cooling capacity shall be increase

Free cooling capacity modulation



	FC disabled	FC 1 st step	FC 2 nd step
1 Bypass Valve	100%	100% ▶ 0% for TFC 100% ▶ 30% for PFC	0% for TFC 30% for PFC
2 FC valve	CLOSE	0% ▶ 100% (modulating)	100%
3 Condenser fan airflow	Follow compressor fan sequence	0% or follow compressor fan sequence if compressor are still running	0% ▶ 100% or follow compressor fan sequence if compressor are still running
4 FC pump	OFF	ON	ON

Freeze protection (only for Glycol free version)

If Free cooling is active, the pump is ON. At start up or when heat transfer over the drycooler increases, the glycol stored in the system could be very cold, resulting in freezing risk on the BPHE. To avoid this, the strategy is to run the pump with recirculation of the glycol in a short loop (dotted line arrow). The freeze protection mode is targeted to restore positive temperature at BPHE glycol inlet. The heat from return chilled water and from the pump heat loss will try to maintain the BPHE glycol temperature above 0°C.

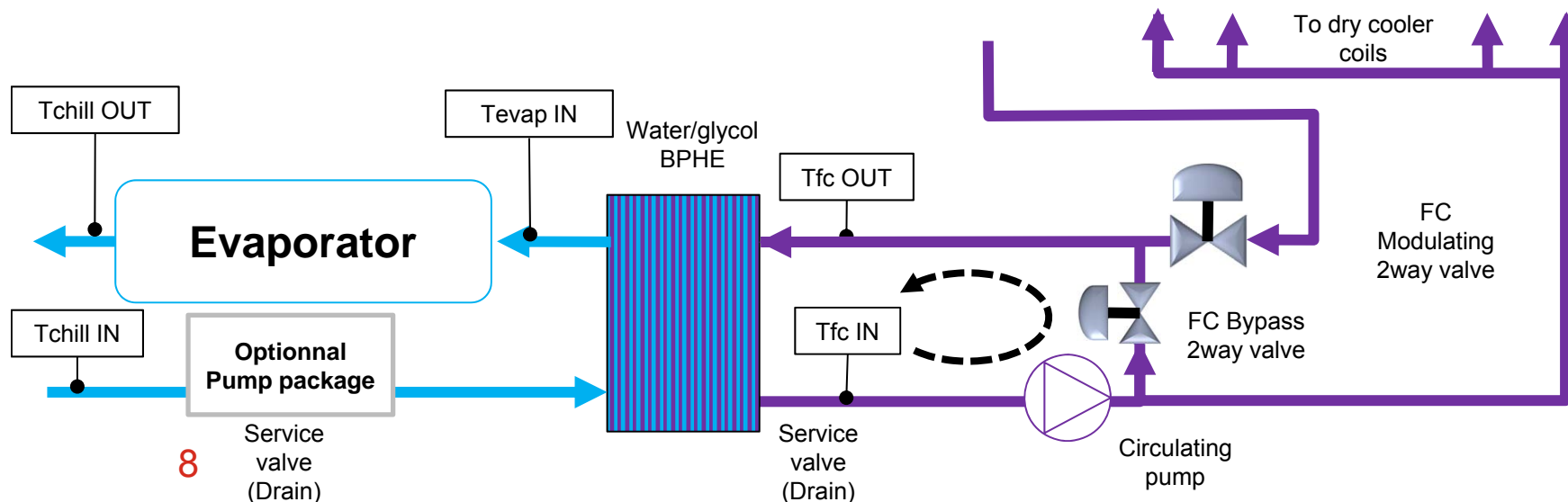
Difficulty here is to have quick enough system response to avoid partial freezing into the BPHE

Condition to have freeze protection active:

- Outdoor air temperature $< 3^{\circ}\text{C}$
- Free cooling is active : Chiller water flow is present & there is a call for cooling.
- If Tfc OUT is $<$ chilled water freeze protection setpoint and FC pump is ON then we are in FC freeze protection mode

FC Freeze protection limiting mode :

- Reduce Free cooling capacity to keep TfcOUT $>$ chilled water freeze protection setpoint from 100% to 0% (following accelerated unload sequence).
- If Tfc IN $<$ chilled water freeze protection then
 - Lockout free cooling operation and report alarm. Auto reset when Outdoor temperature is $> 3^{\circ}\text{C}$.



Schedule

