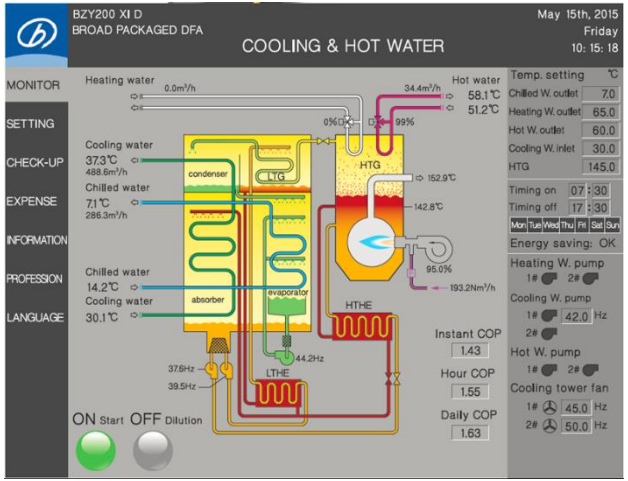
2021 BROAD Chiller Service Webinar Series 2#

Control Sequence and Interface



BROAD U.S.A.

Control Sequence and Interface

1) Chiller control system design concept

2) Electrical diagram & control panel

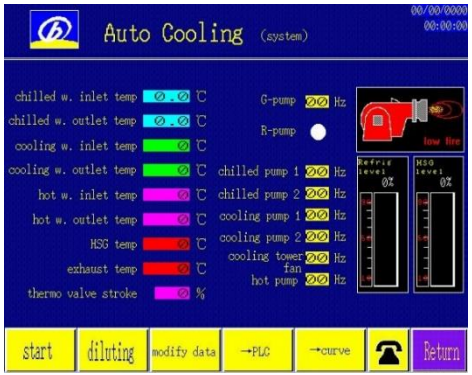
3) Chiller startup and dilution off sequence

4) Chiller interface

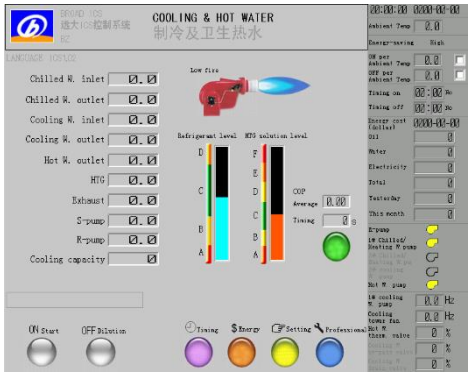
5) Water system control suggestion

1.Chiller Control System Design Concept：Continuous Operation

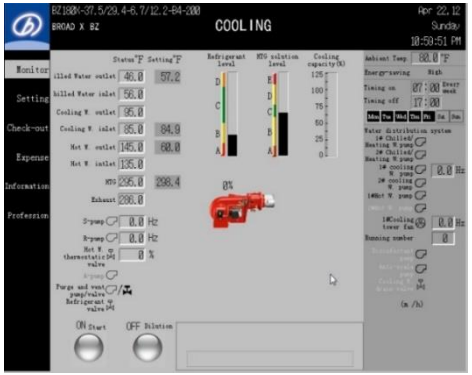
- Fully automatic control system with PLC(Programmable logic controller) based
- Potential fault detection, fault auto reset
- Self diagnosis and recovery system
- Energy saving operation
- BMS/BAS interface (Dry contact, BACnet, Modbus, Profibus)
- Water system control (Pumps, valve, cooling tower)



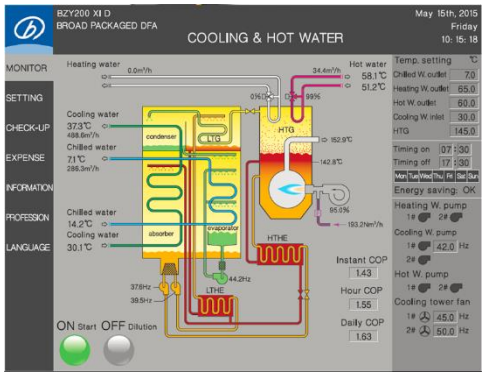
(1998-2003) – VII,VIII



(2004-2008) - IX



(2009-2016) – X



(2017-2021)- XI,XII

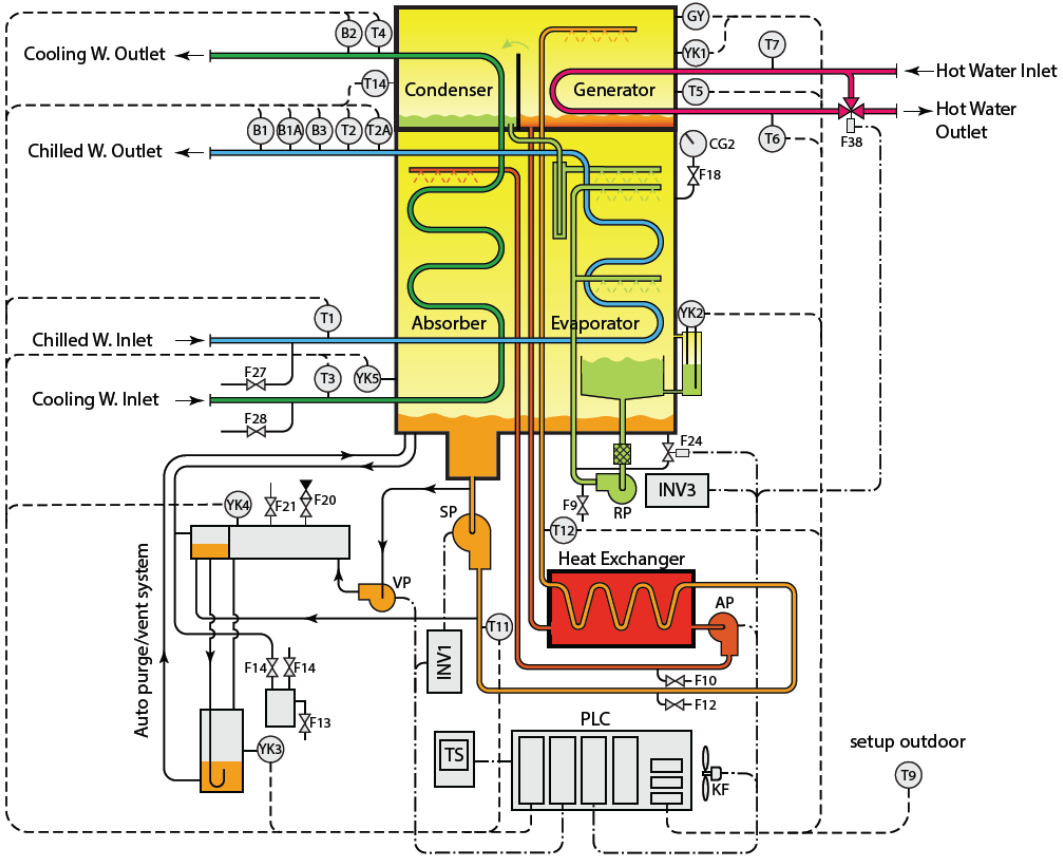
2. Electrical diagram & Control panel

CONTROL DEVICES

INVI	Solution pump inverter
INV3	Refrigerant pump inverter
TS	Programmable logic
PLC	Controller

CONTROLLED OBJECTS

RP	Refrigerant pump
SP	Solution pump
VP	Air vent pump
AP	Absorption pump
F24	Refrigerant by-pass valve
F38	Hot water motor valve
KF	Control cabinet fan



P&I Diagram

SENSORS

T1	Chilled Water inlet sensor
T2	Chilled water outlet sensor
T2A	Chilled water calibration sensor
T3	Cooling water inlet sensor
T4	Cooling water outlet sensor
T5	Generator temperature sensor
T6	Condensate outlet temp. sensor
T7	Steam inlet temperature sensor
T9	Ambient temperature sensor
T10	HTG crystallization sensor
T11	Diluted solution inlet temp. sensor
T12	Generator crystallization sensor
T13	Control cabinet temp. sensor
T14	Condenser temperature sensor

B1	Chilled water flow switch
B1A	Chilled water flow switch
B2	Cooling water flow switch
B3	Chilled water flow switch

GY	Pressure control
YK1	Generator solution level probe
YK2	Refrigerant level probe
YK3	Non-condensible gas sensor
YK4	Auto vent probe
YK5	Absorber solution level probe

Control device

Level Sensor

Flow switch

Pressure switch

Temperature Controller

12~16 of Temperature Sensor

Program Logic controller(PLC)

VFD for pump

Touchscreen

Burner

Valve

Control Panel (500 tons or below)

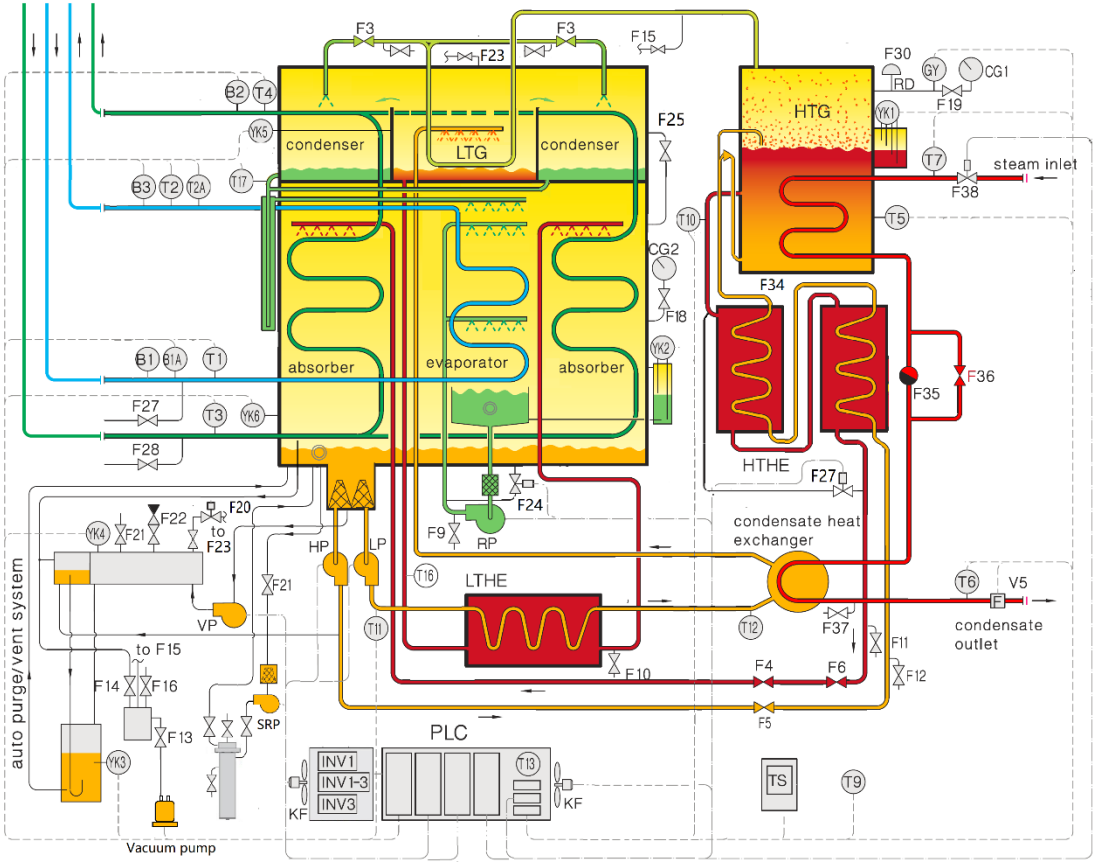
P&I Diagram

Control Devices:

INV1	HTG solution pump inverter
INV1-3	LTG solution pump inverter
INV3	Refrigerant pump inverter
TS	Programmable logic
PLC	Controller

Controlled Objects:

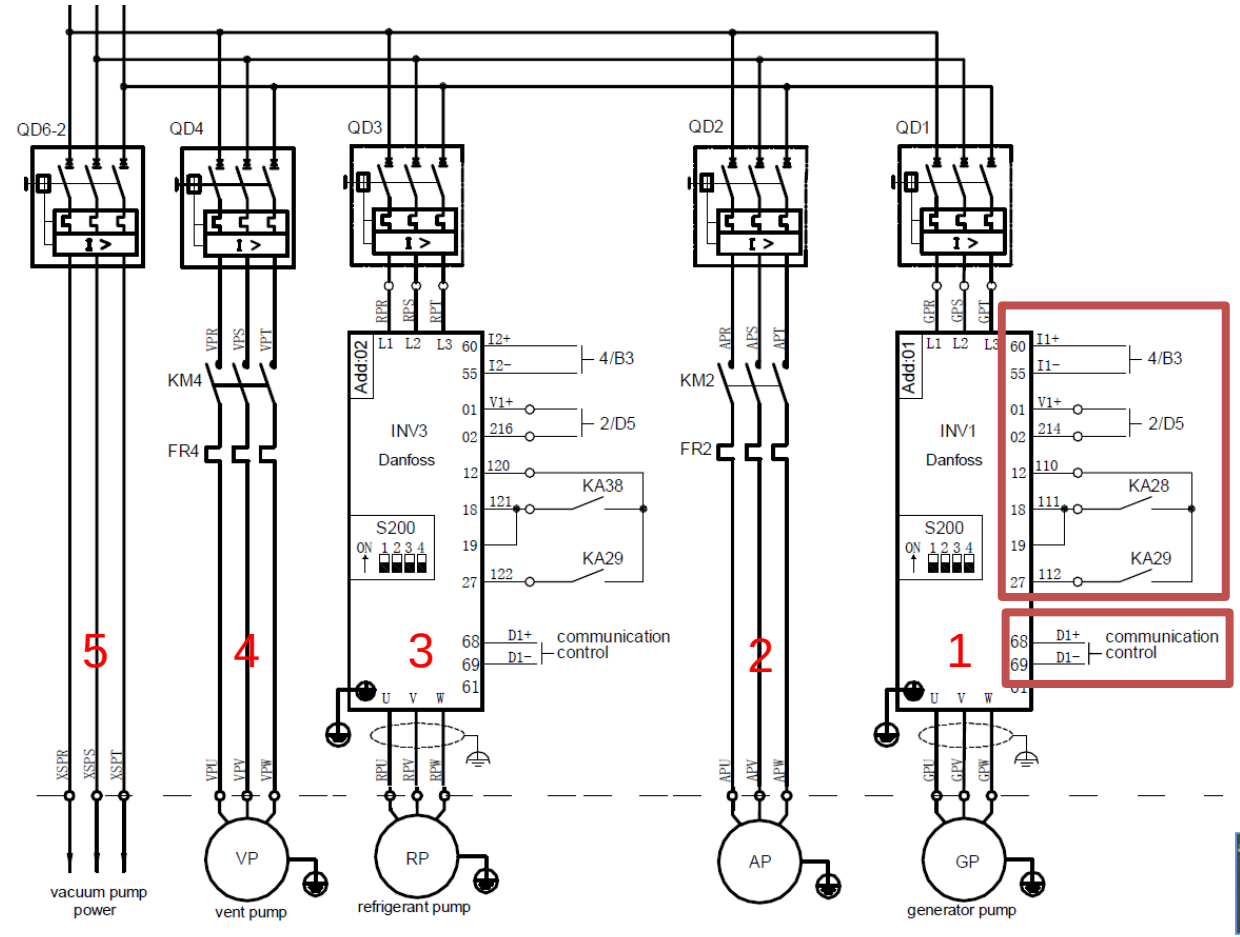
RP	Refrigerant pump
LP	LTG solution pump
HP	HTG solution pump
VP	Air vent pump
SRP	Solution regenerator pump
F20	Purge chamber solenoid valve
F24	Refrigerant motor valve
F27	HTHE strong solution bypass valve
F38	Steam motor valve
KF	Control cabinet fan

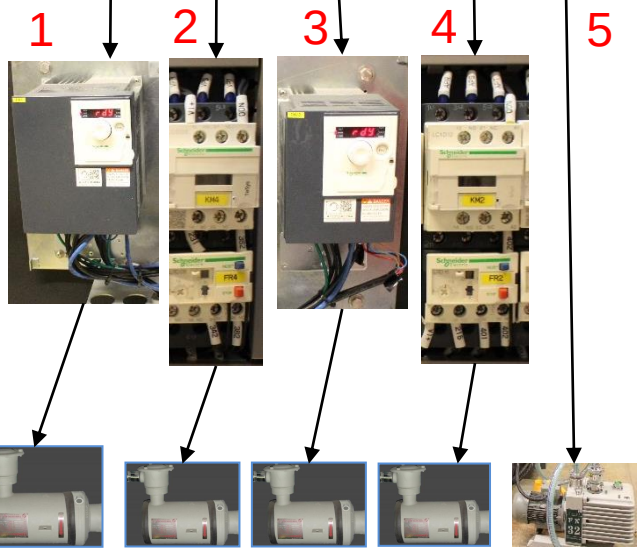


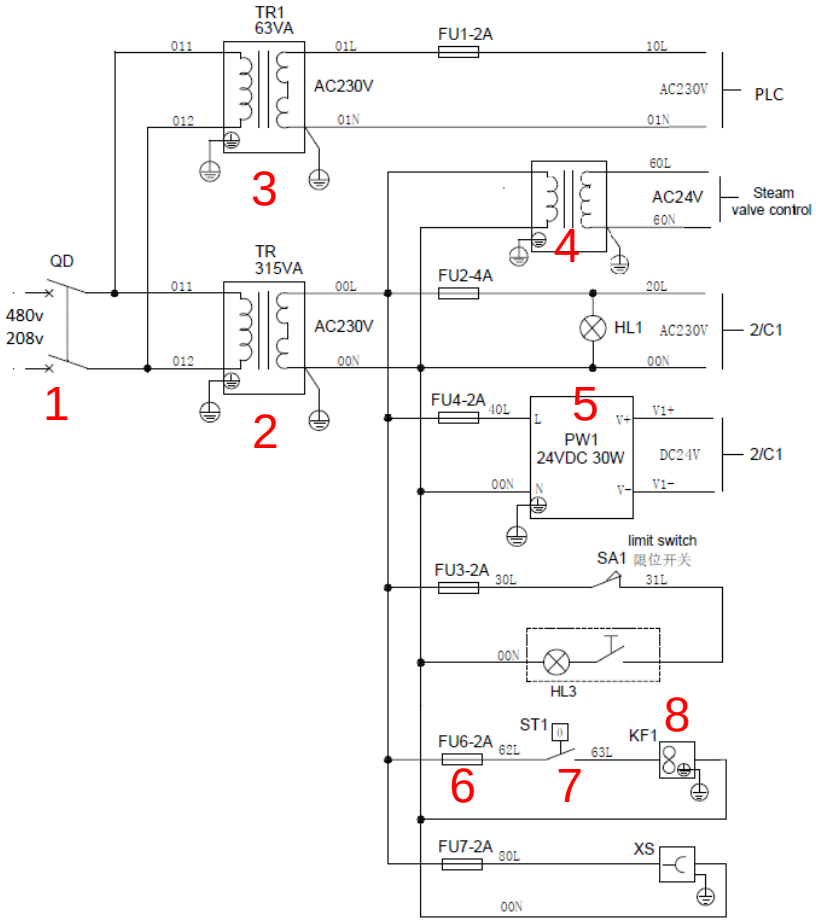
Sensors:

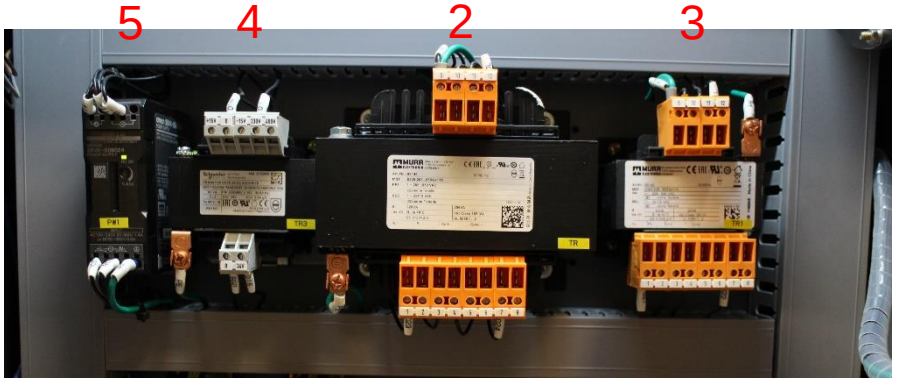
T1	Chilled W. inlet temp. sensor
T2	Chilled W. outlet temp. sensor
T2A	Chilled W. calibration temp. sensor
T3	Cooling W. inlet temp. sensor
T4	Cooling W. outlet temp. sensor
T5	HTG temp. sensor
T6	Condensate outlet temp. sensor
T7	Steam inlet temp. sensor
T9	ambient temp. sensor
T10	HTG crystallization sensor
T11	LTHE diluted solution inlet temperature sensor
T12	LTG crystallization sensor
T13	Control cabinet temp. sensor
T16	LTG temp. sensor
T17	Condenser refrigerant temp. sensor
B1	Chilled W. flow switch
B1A	Chilled W. flow switch
B2	Cooling W. flow switch
B3	Chilled W. flow switch
GY	Pressure control
YK1	HTG solution level probe
YK2	Refrigerant level probe
YK3	Non- condensable gas sensor
YK4	Auto vent probe
YK5	LTG solution level probe
YK6	Absorber solution level probe
V5	Condensate flowmeter

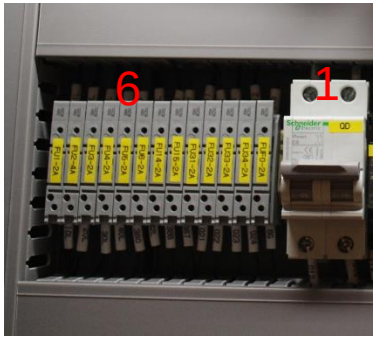
Chiller Control Panel (600 ton up)

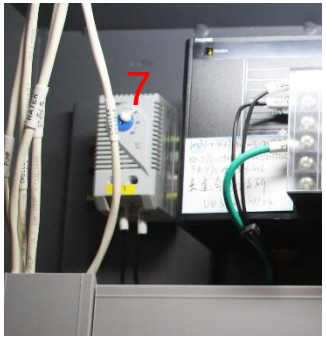

QD6-2
QD4
QD3
QD2
QD1
KM4
FR4
KM2
FR2
INV3
Danfoss
INV1
Danfoss
Add:02
Add:01
S200
4/B3
2/D5
KA38
KA29
KA28
communication control
5
4
3
2
1
vacuum pump power
vent pump
refrigerant pump
generator pump
VP
RP
AP
GP


1
2
3
4
5

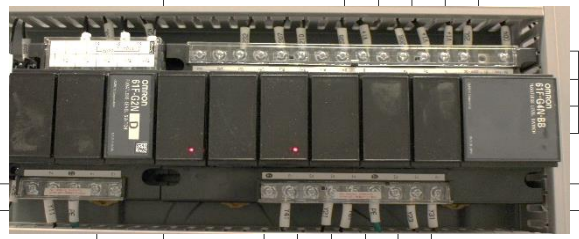

TR1
63VA
011
012
01L
01N
FU1-2A
10L
AC230V
AC230V
PLC
3
60L
AC24V
60N
Steam
valve control
4
QD
480v
208v
1
TR
315VA
011
012
00L
00N
AC230V
FU2-4A
20L
HL1
AC230V
00N
2/C1
2
FU4-2A
40L
5
PW1
24VDC 30W
L
N
V+
V-
V1+
V1-
00N
2/C1
limit switch
SA1 限位开关
FU3-2A
30L
31L
00N
HL3
8
ST1
FU6-2A
62L
63L
KF1
6
7
FU7-2A
60L
XS
00N


5
4
2
3


6
1


7


8



generator solution level probe 发生器液位传感器 YK1
refrigerant level probe 冷剂液位传感器 YK2.1
non-condensable probe 贮气筒传感器 YK2.3
auto-vent probe 自动排气传感器 YK3
absorber room probe 吸收器液位传感器 YK4
YK6
chilled water flow switch 冷水流量控制器 B1A
chilled water flow switch 冷水流量控制器 B1
cooling water flow switch 冷却水流量控制器 B2
pressure control 压力控制器 GY
BAS control 楼宇控制
SON BAS on 楼宇开机
SOFF BAS off 楼宇停机
GEO heat source request feedback 热源请求反馈

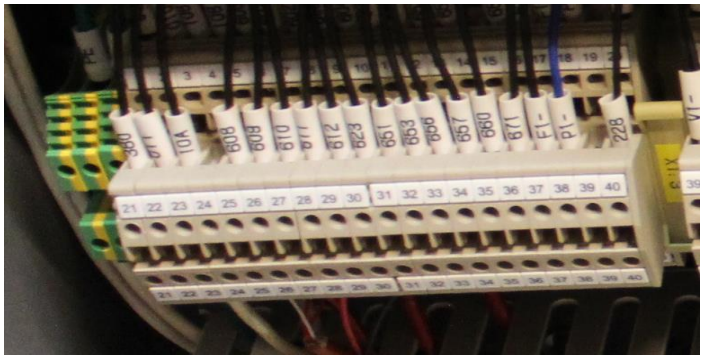
1/B8 20L 00N 3/E1
1/C8 V1+ V1− 3/B1
1/A8 10L 01N
communication control 通讯控制
heat source valve control 热源阀控制

INV1 FR2 INV3 SB2 KM4

CJ1W-PA205R | CJ2M-CPU14 | CJ1W-SCU41 | CJ1W-SCU41 (CJ1W-PRT21)

generator solution level 发生器液位
BAS on 楼宇开机
BAS off 楼宇停机
stop switch 停机按钮
heat source request feedback 热源请求反馈
VP contactor feedback 排气泵接触器反馈
auto-vent 自动排气
heat source valve feedback 热源阀反馈


BROAD X BZ
Check I/O
2015.10.22
Sunday
00:47:54
Monitor
Setting
Check
Expense
Information
Profession
Language
OD231-B
0
1
2 Anti-scales quality open/close
3 Cooling W.drain valve open
4 Cooling W.drain valve close
5 Bactericide quality open/close
6 LTGP inverter run
7
8 1# Chilled W.pump run
9 2# Chilled W.pump run
10 1# Cooling W.pump run
11 2# Cooling W.pump run
12 Cooling fan run
13 Hot W.pump run
14
15
OC211-1
0 Fault pilot lamp
1 Control casing fan run
2 Vent pump run
3
4
5
6
7
8 Hot W. thermostatic valve open
9 Hot W. thermostatic valve close
10 Heating W. thermostatic valve open
11 Heating W. thermostatic valve close
12
13
14
15
DRT2-TS04P-1 NODE:11
780 IN0 Ambient temp.
850 IN1 Control casing temp.
1450 IN2 Hot W. inlet temp.
1500 IN3 Heating W. inlet temp.
DRT2-TS04P-2 NODE:23
2930 IN0 HTG temp.
2880 IN1 HTG crystallization temp.
1750 IN2 Hot W. outlet temp.
940 IN3 LTHE diluted solution inlet
DRT2-TS04P-3 NODE:15
550 IN0 Chilled W. inlet temp.
845 IN1 Cooling W. inlet temp.
1750 IN2 Heating W. outlet temp.
3650 IN3 Exhaust temp.
DRT2-TS04P-4 NODE:19
450 IN0 Chilled W. outlet temp.
950 IN1 Cooling W. outlet temp.
450 IN2 Chilled W. calibrating temp.
1680 IN3 LTHE crystallization temp.
1
2
3
Running operation
Operation record
Fault record
Check I/O



CJ1W-OD231

B

1.01	1.02	1.03	1.04	1.05	1.06	1.07			1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15		
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
322	323	324	325	326			V1-	V1+	331	332	333	334	335		337	338	V1-	V1+
KA27	KA88	KA86	KA87	KA89					KA8	KA9	KA10	KA11	KA12		KA14	KA15		

2# cooling fan run 2#冷却风机运行
anti-scales, quality stabilizer valve open/close 阻垢剂加药阀开/关
cooling W.drain valve open 冷却水排水阀开
cooling W.drain valve close 冷却水排水阀关
bactericide quality stabilizer valve open/close 杀菌剂加药阀开/关
1# chilled W. pump run 1#冷水泵运行
2# chilled W. pump run 2#冷水泵运行
1# cooling W. pump run 1#冷却水泵运行
2# cooling W. pump run 2#冷却水泵运行
1# cooling fan run 1#冷却风机运行
1# heating W. pump run 1#温水泵运行
2# heating W. pump run 2#温水泵运行

V1+
DC24V
V1-

4/B1

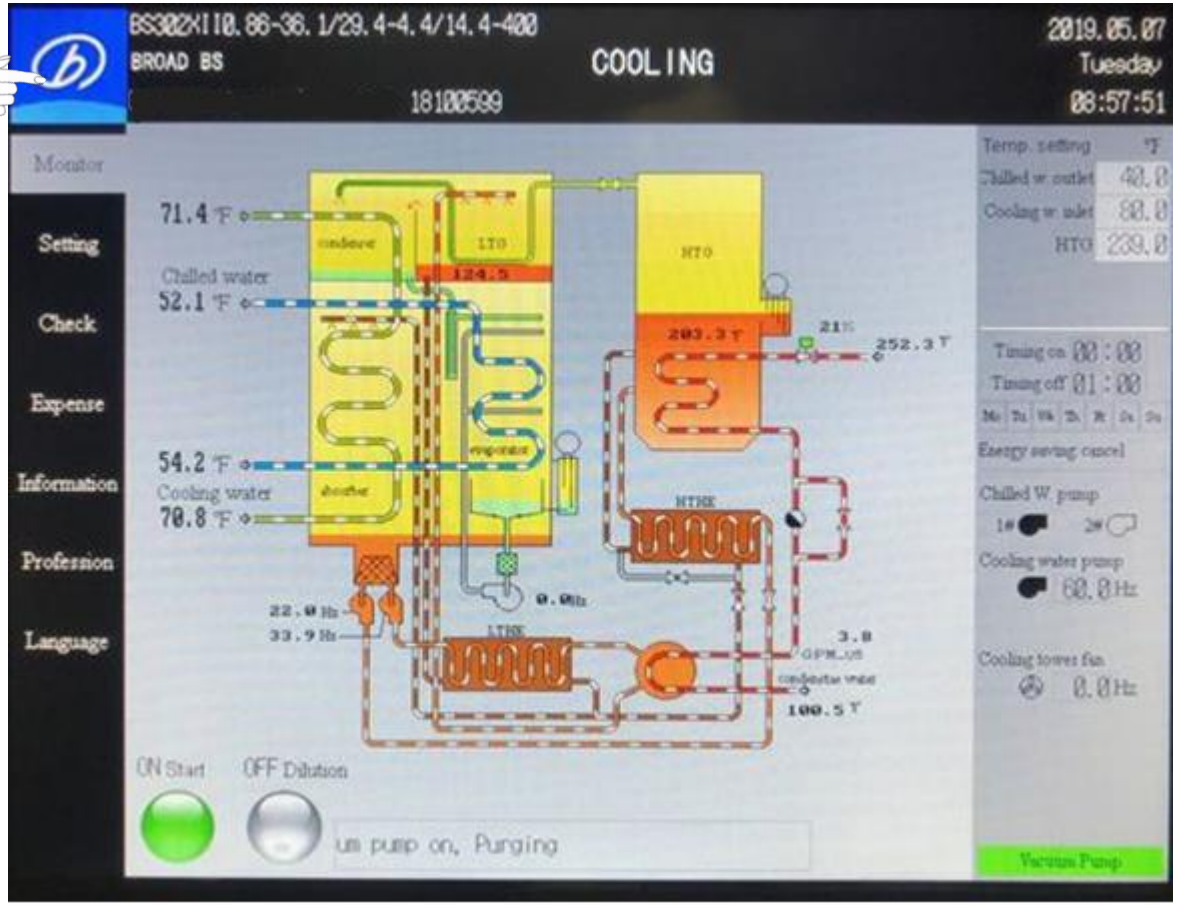
KA27	KA88	KA86	KA87	KA89	KA8	KA9	KA10	KA11	KA12	KA14	KA15	KA85
622	623	652	653	655	656	657	659	660	600	608	601	609	602	610	603	611	604	612	606	614	607	615	650	651

water system
水系统

V1-
359
B3
chilled W. 3-stage protection
冷水3级保护

PLC arrangement diagram

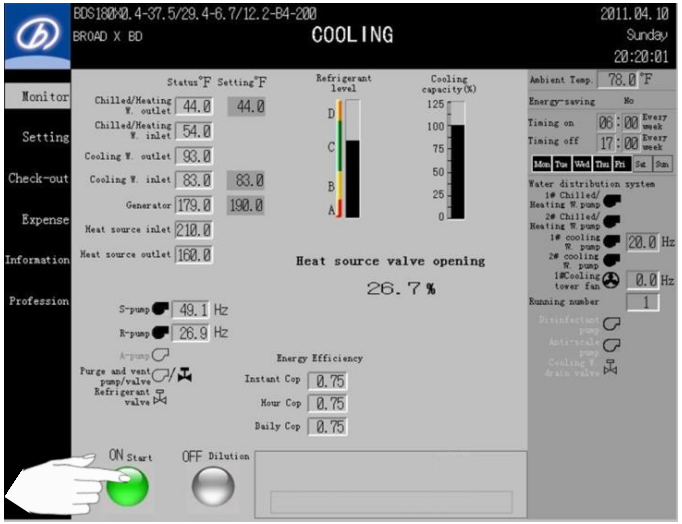

NDENSATE


BS302XII0.86-36.1/29.4-4.4/14.4-400
BROAD BS
COOLING
18100599
2019.05.07
Tuesday
08:57:51
Monitor
Setting
Check
Expense
Information
Profession
Language
71.4 °F
Chilled water
52.1 °F
54.2 °F
Cooling water
70.8 °F
LTO
HTO
124.5
203.3 °F
252.3 °F
HTOE
LTOE
22.0 Hz
33.9 Hz
0.0 Hz
3.8
GPM_US
100.5 °F
ON Start
OFF Dilution
us pump on, Purging
Temp. setting °F
Chilled w. outlet 42.8
Cooling w. inlet 88.0
HTO 239.0
Timing on 00:00
Timing off 01:00
Energy saving cancel
Chilled W. pump
Cooling water pump
60.0 Hz
Cooling tower fan
0.0 Hz
Vacuum Pump

2. Chiller Startup and Dilution off Sequence

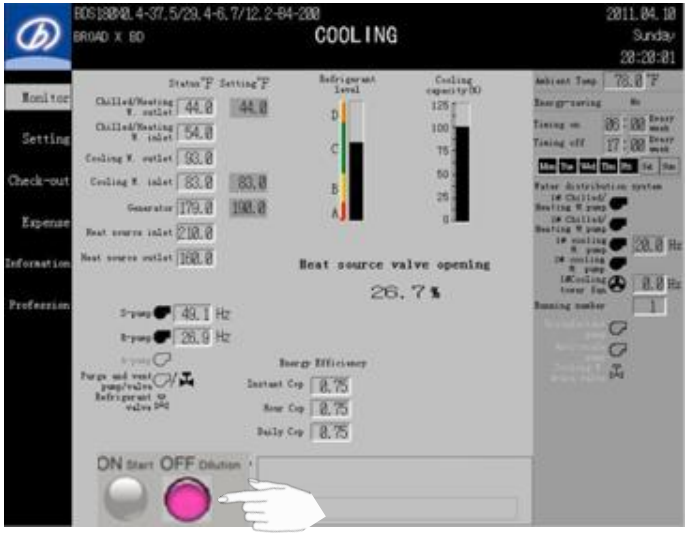
Start:

- Press “ ON Start” button will turn green
- Chilled water and Condenser water pumps will start
- After both water flow detected, chiller will proceed to meet set point

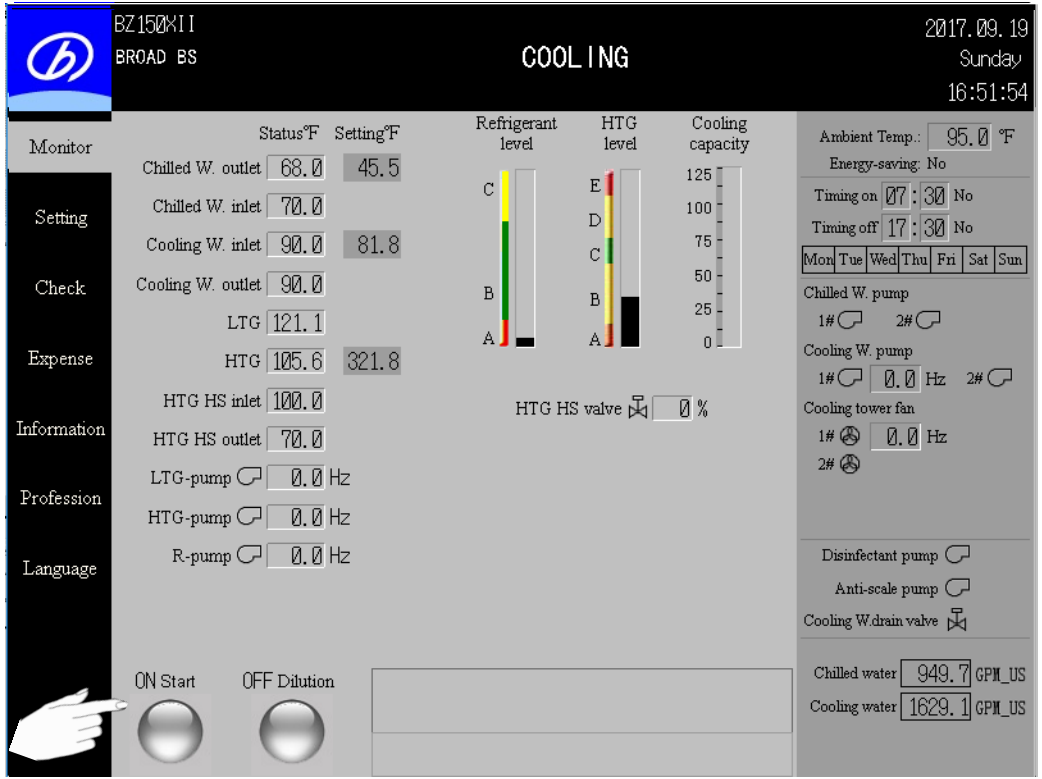


Off Dilution:

- Press “OFF Dilution” button will turn purple
- The heat source will close (burner/valve)
- Generator temperature will cool down to 135/175F
- Dilution Time: 30~90 mins depending of chiller size

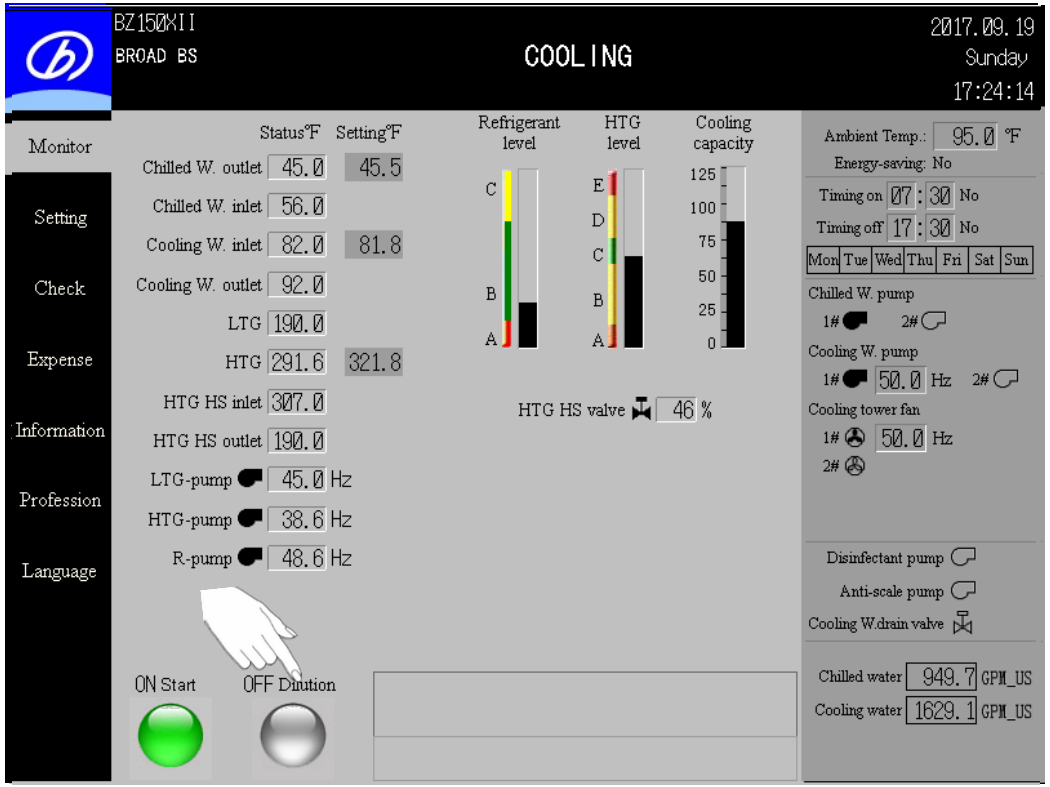


Control System – Chiller Start Sequence

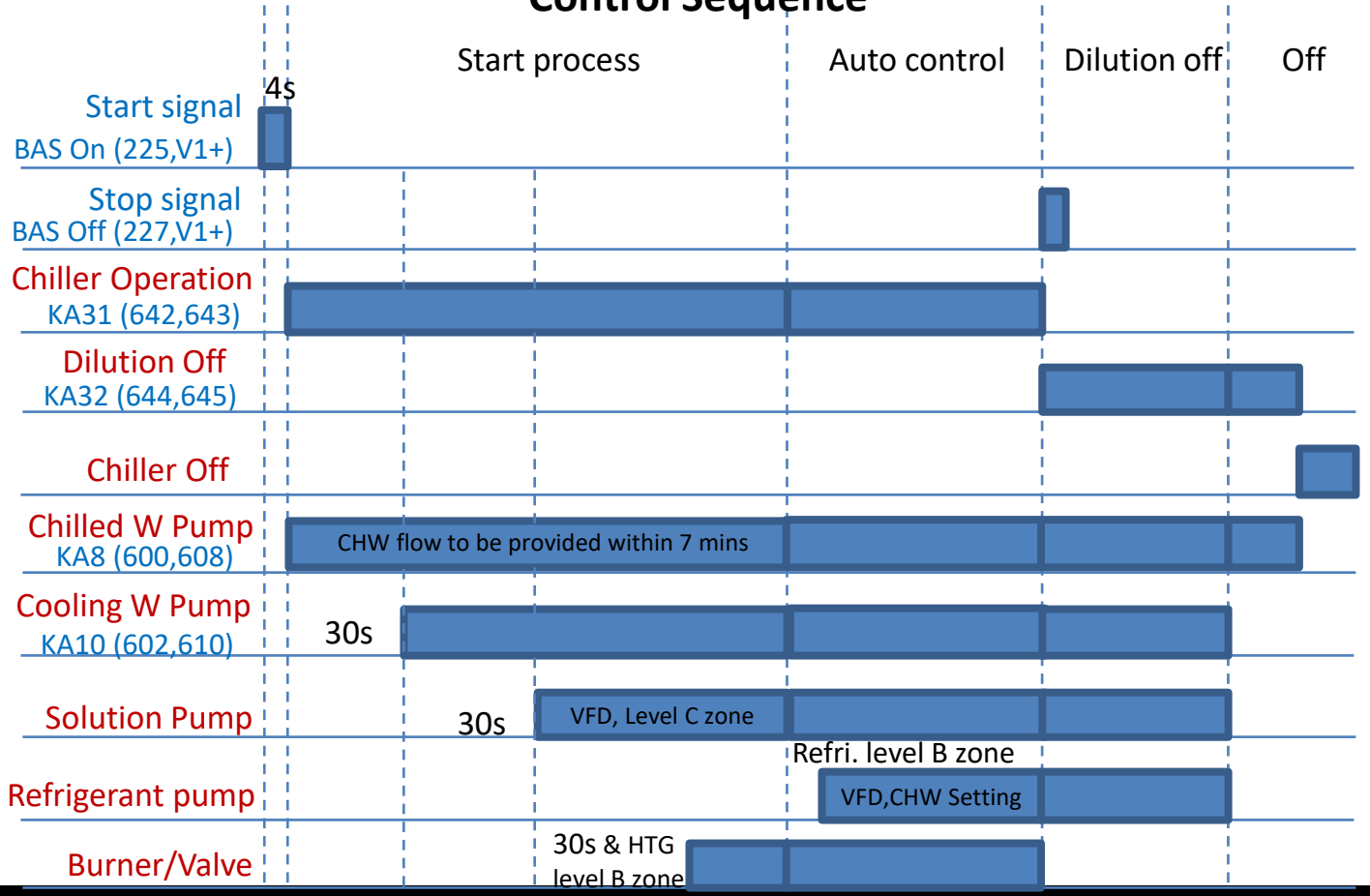


ID231-A	
0	HTG solution level 1
1	HTG solution level 2
2	HTG solution level 3
3	
4	HTG solution level 4 (op.)
5	Refrigerant level 1
6	Refrigerant level 2
7	Refrigerant level 3(op.)
8	Non-condensable
9	Chilled W. flow switch
10	Chilled W. flow switch
11	Cooling W. flow switch
12	SP inverter feedback(op.)
13	
14	RP inverter feedback(op.)
15	HTG pressure control (op.)

Control System – Chiller OFF Sequence



Control Sequence



Dilution Cycle

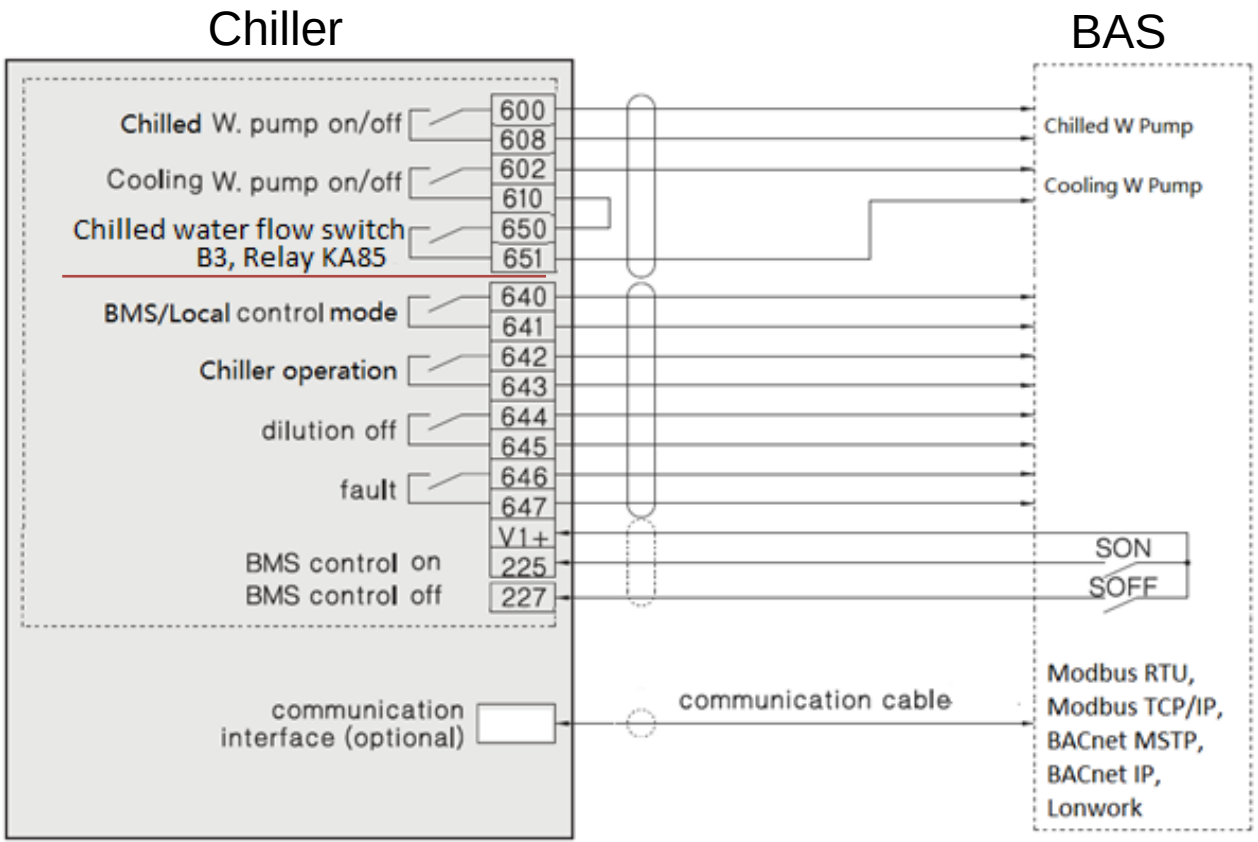
Why?

- Prevents the LiBr solution from damaging the heat exchangers with the generator pressure high cause back flow.
- Prevent any accidents such as frozen tubes or crystallization

During Dilution Cycle

- All the pumps continuous to run
- The concentrated solution becomes diluted as it absorbs the evaporated refrigerant
- Heat is removed by the **cooling water**
- The solution temperature will be reduced slowly

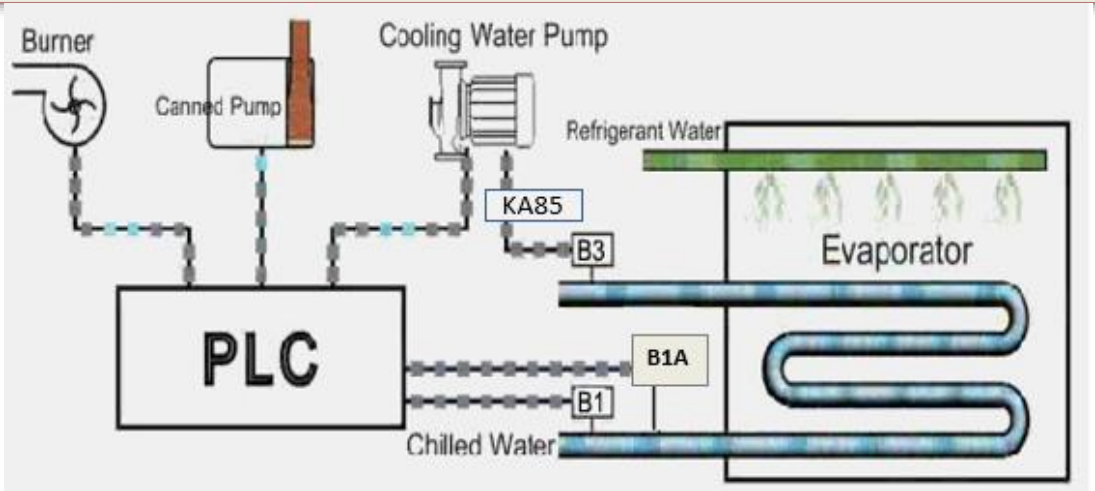
Control Sequence - BAS interface:



Control System - 3rd Stage Protection

BROAD chiller provides 3 chilled water flow switches:

- B1: flow signal (connected to PLC program sequence interlock)
- B1A: flow signal (connected to PLC program sequence interlock)
- B3: flow signal (Energize relay KA85 if have flow) the normal open terminal has to be wired to condenser water pump, once chilled water flow status is unsatisfied, KA85 relay de-energizes, condenser water pump should be shut off.



3. Chiller interface

Chilled Water Outlet Temperature:

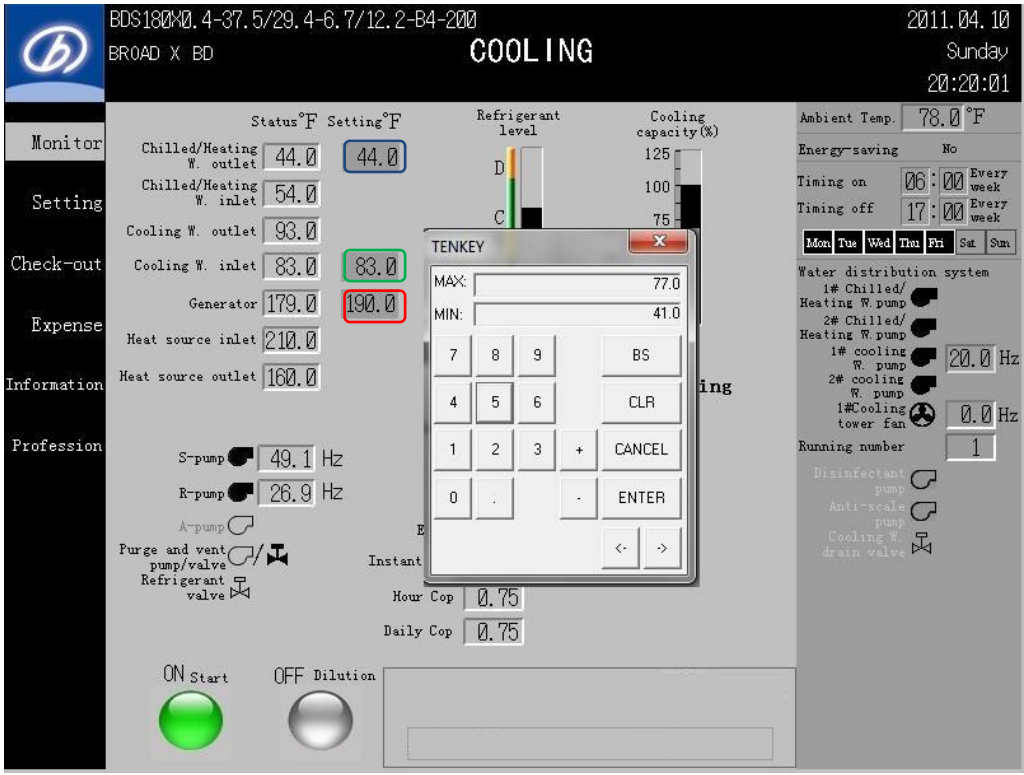
- **Range 41 to 77 degrees ºF, default 45ºF**
  The higher the more energy efficient

Condenser Water Inlet Temperature:

- **Range 74～93 ºF, default 83 ºF**

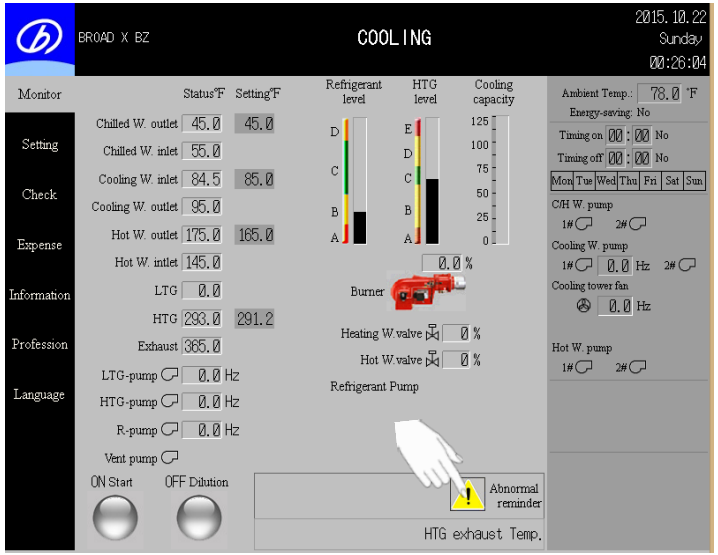
Generator Temperature:

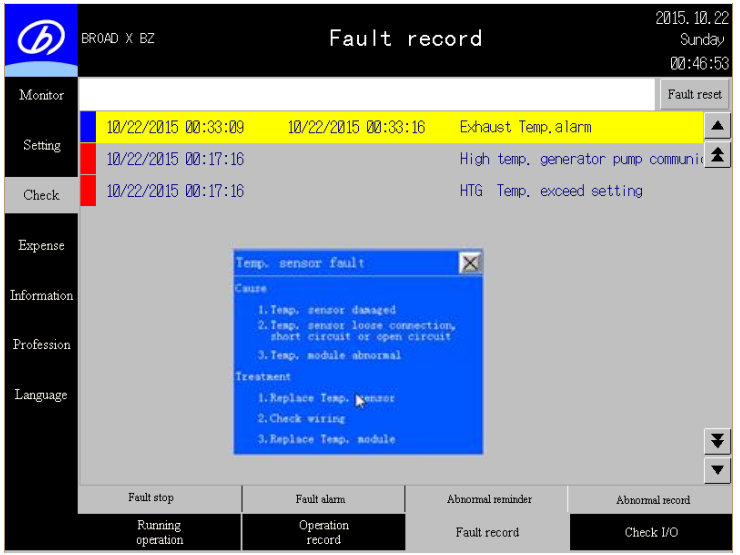
- **Single Stage – Range 150ºF~203 ºF , default 193 ºF**
- Double Stage - Range 248 ºF~310 ºF , default 293 ºF



Alarm notice

1. Enter fault record by pressing the caution icon
2. Fault record will enable you to see: Fault name, occurring time of the fault, resetting time and abnormal reminder
3. Press the fault and follow the instructions





Selection Mode

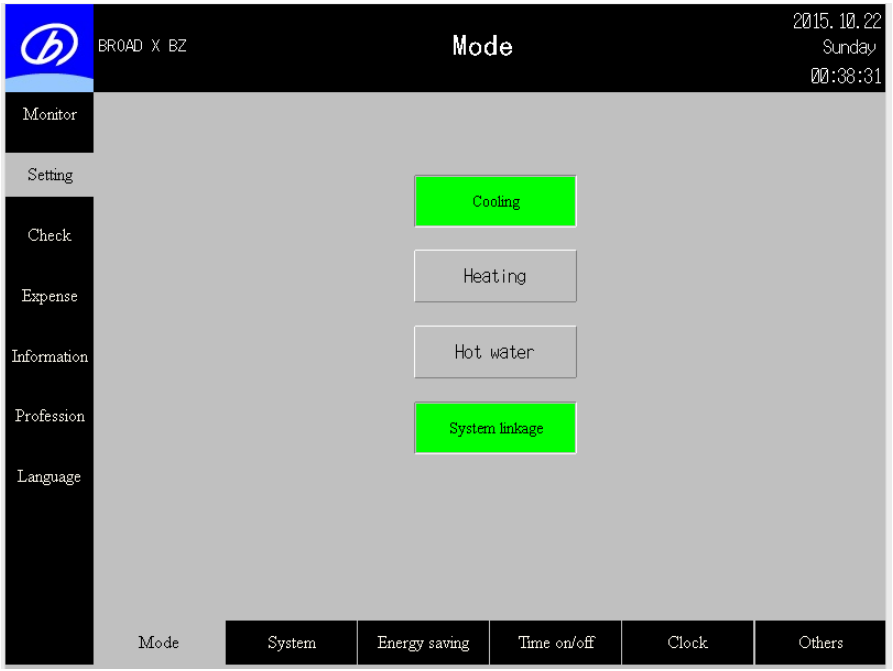
Press “Setting” to enter setting interface, then press “Mode” to enter.

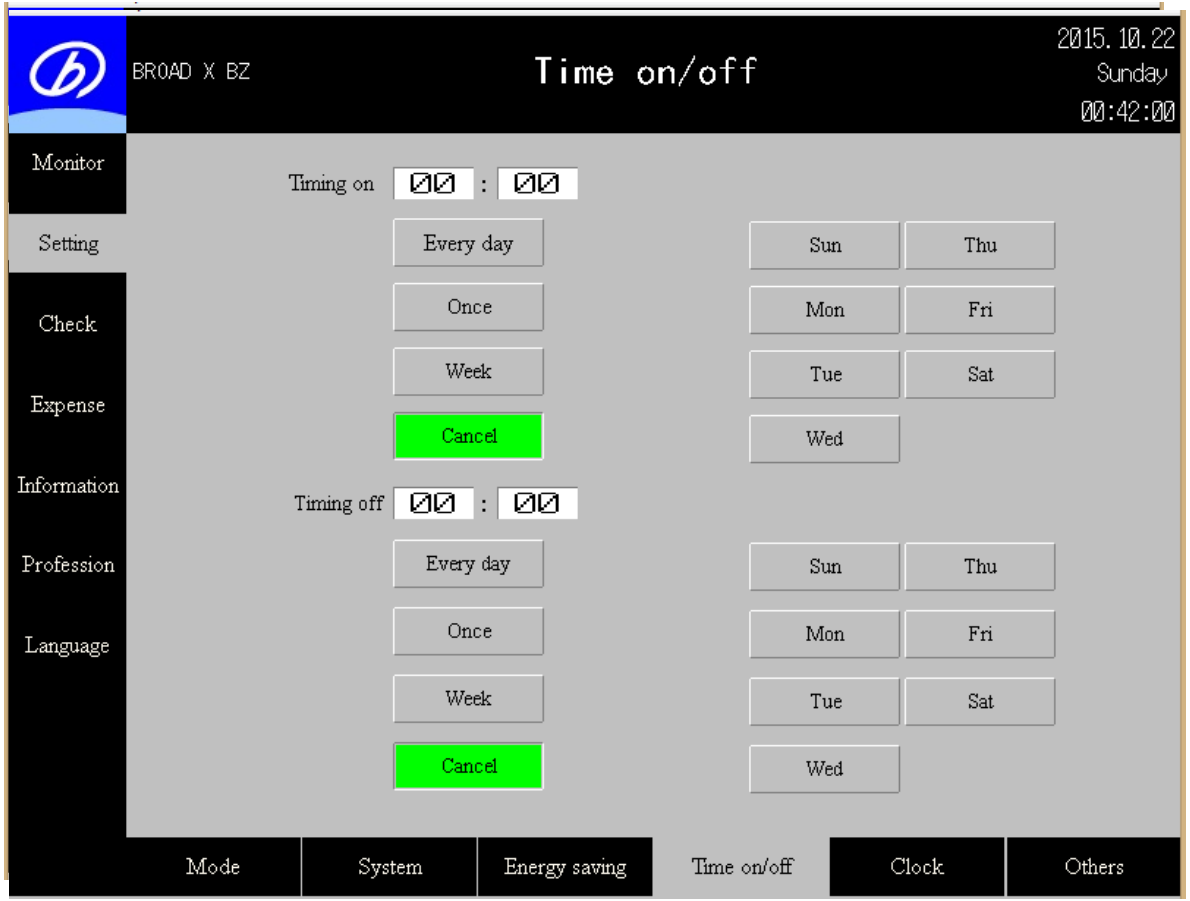
COOLING

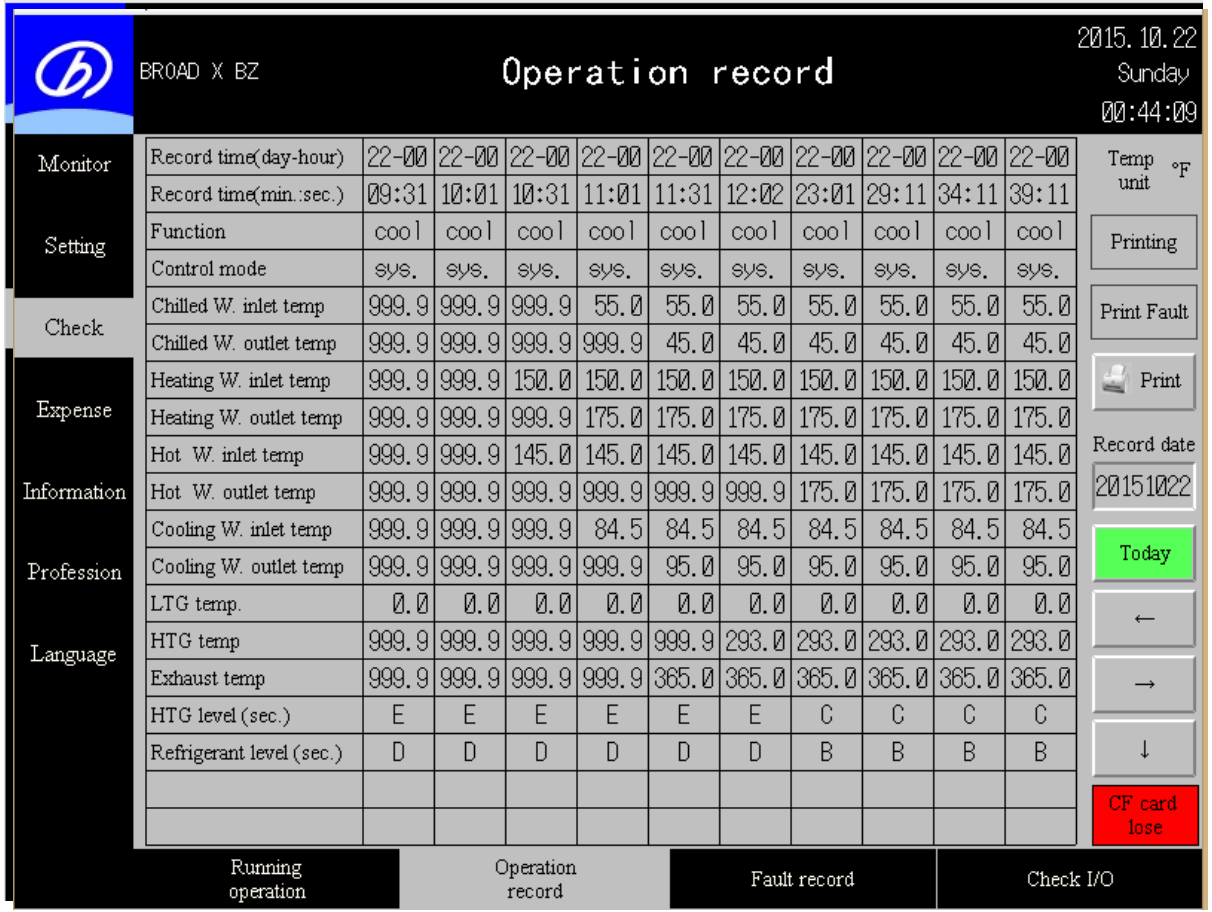
a. Make sure the steam angle valve, concentrated solution angle valve and diluted solution angle valve are fully open.

b. Make sure the chilled water and cooling water drain valves are closed, and the heating water and hot water drain valve are fully open.

c. Make sure the system’s cooling-heating switch valve is switched to cooling position and the system is full of water.




BROAD X BZ
Time on/off
2015.10.22
Sunday
00:42:00
Monitor
Setting
Check
Expense
Information
Profession
Language
Timing on
Every day
Once
Week
Cancel
Sun
Thu
Mon
Fri
Tue
Sat
Wed
Timing off
Every day
Once
Week
Cancel
Sun
Thu
Mon
Fri
Tue
Sat
Wed
Mode
System
Energy saving
Time on/off
Clock
Others



Record time(day-hour)	22-00	22-00	22-00	22-00	22-00	22-00	22-00	22-00	22-00	22-00
Record time(min.:sec.)	09:31	10:01	10:31	11:01	11:31	12:02	23:01	29:11	34:11	39:11
Function	cool	cool	cool	cool	cool	cool	cool	cool	cool	cool
Control mode	sys.	sys.	sys.	sys.	sys.	sys.	sys.	sys.	sys.	sys.
Chilled W. inlet temp	999.9	999.9	999.9	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Chilled W. outlet temp	999.9	999.9	999.9	999.9	45.0	45.0	45.0	45.0	45.0	45.0
Heating W. inlet temp	999.9	999.9	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
Heating W. outlet temp	999.9	999.9	999.9	175.0	175.0	175.0	175.0	175.0	175.0	175.0
Hot W. inlet temp	999.9	999.9	145.0	145.0	145.0	145.0	145.0	145.0	145.0	145.0
Hot W. outlet temp	999.9	999.9	999.9	999.9	999.9	999.9	175.0	175.0	175.0	175.0
Cooling W. inlet temp	999.9	999.9	999.9	84.5	84.5	84.5	84.5	84.5	84.5	84.5
Cooling W. outlet temp	999.9	999.9	999.9	999.9	95.0	95.0	95.0	95.0	95.0	95.0
LTG temp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HTG temp	999.9	999.9	999.9	999.9	999.9	293.0	293.0	293.0	293.0	293.0
Exhaust temp	999.9	999.9	999.9	999.9	365.0	365.0	365.0	365.0	365.0	365.0
HTG level (sec.)	E	E	E	E	E	E	C	C	C	C
Refrigerant level (sec.)	D	D	D	D	D	D	B	B	B	B

5. Water system control suggestion

Chilled Water flow control

1. Chiller requires start and stop control of the chilled water flow;

2. Chiller provide flow switch failure check before and after the chiller start;

3. Chilled should operation on constant flow; requires chilled water return temperature variable rate less 2 ℉ per minute if primary-secondary pump system applied

4. Requires minimum 65% flowrate if variable flow applied and variable rate less 10% per minute

★ **Under no conditions can chiller operation be terminated by stopping chilled water flow;**

Cooling Water flow control

1. Chiller requires start and stop control of the condenser water flow;

2. Chiller provide flow switch failure check before and after the pump start;

3. Failure auto recover programming require to control the condenser water flow(pump or valve);

★ **Condenser water flow must start and stop as determined by chiller control pane, Failure to stop flow risks evaporator freeze-up.**

★ **Operation without proper water pump or flow sensing interlocking will void the unit warranty**

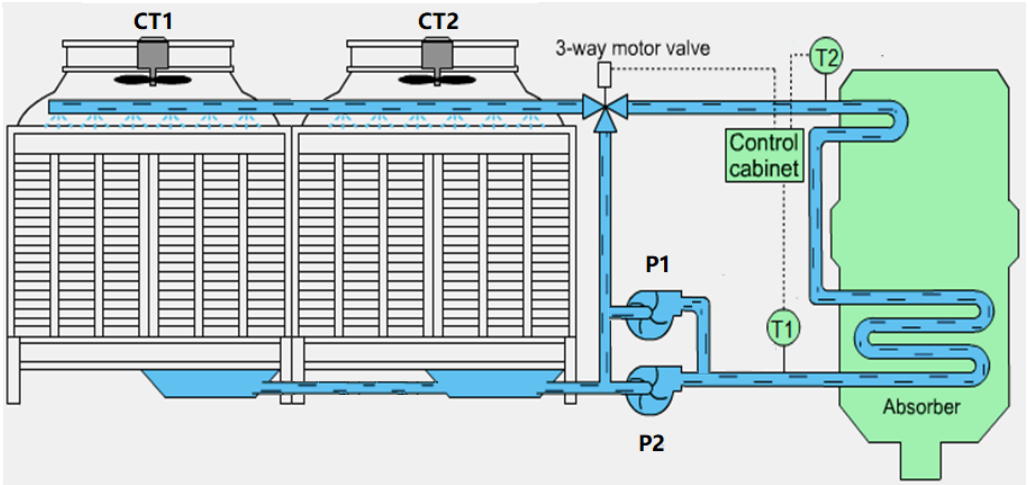
Condenser water temperature control

Common question:

What's the condense water temperature range for operation? 80~85 F

What's lowest temperature for chiller start up? No limit for startup, have limit for operation

What's the recommendation for condenser water temperature control?



Fan VFD control

Bypass valve

Two chiller stage control

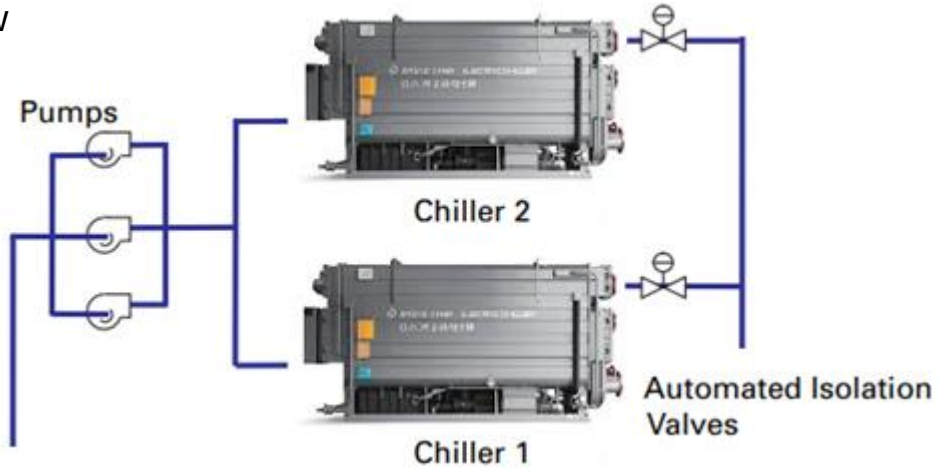
1.What's the condition should start the lag chiller? 80% load

2. What's the condition should stop the lag chiller? 60% load

3. Can both chiller running at the same time? Base system flowrate design

4. Why and how to solve the Lead chiller water flow fault during lag chiller start and stop?

Start pump and valve at same time



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