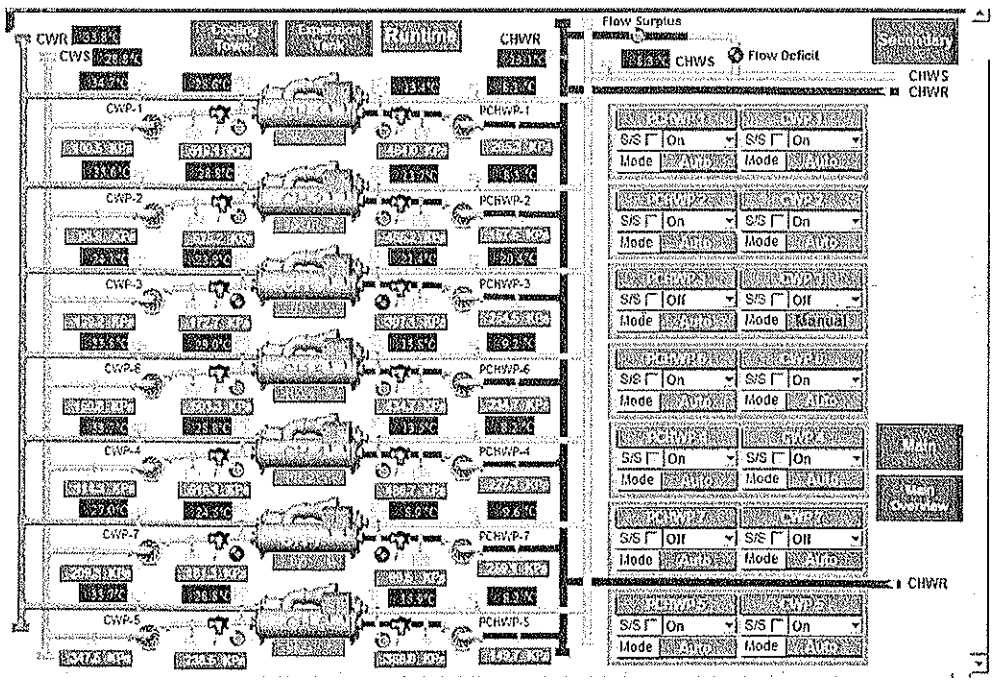
Case studies of chiller plant performance measurement & verification

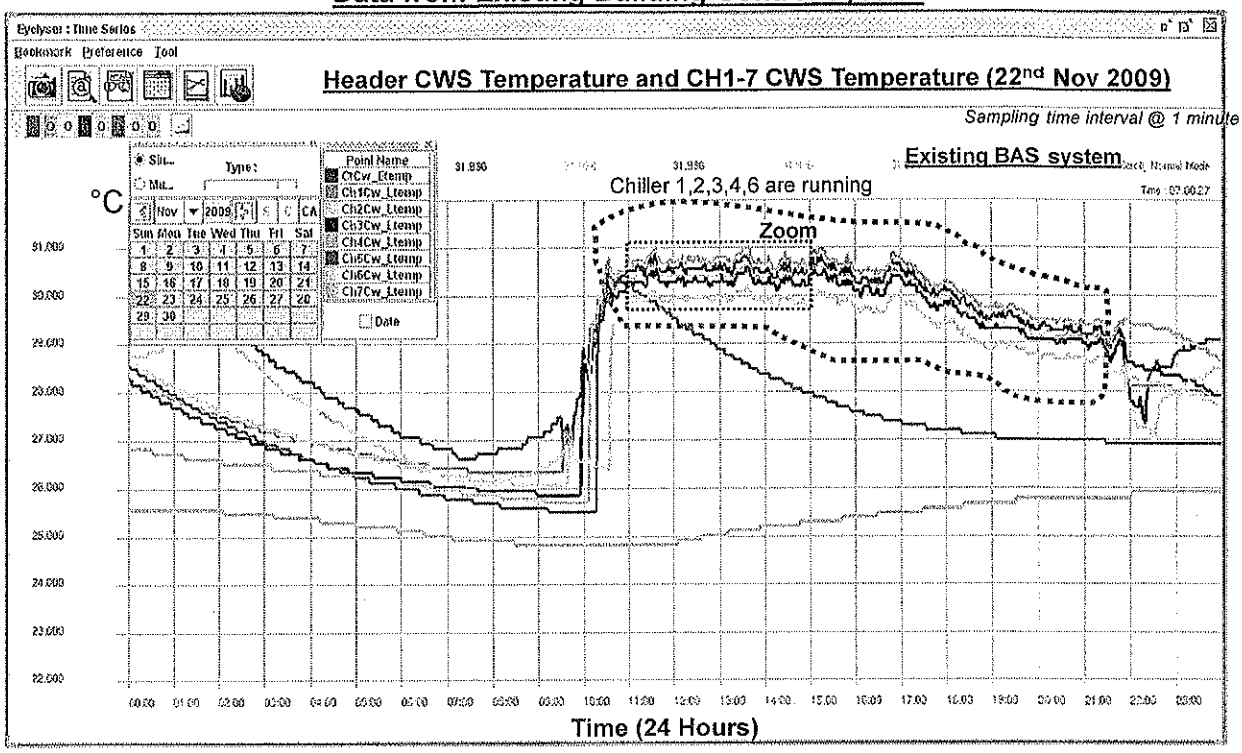
Lee Eng Lock



5 x 1500RT, 2 x 750RT

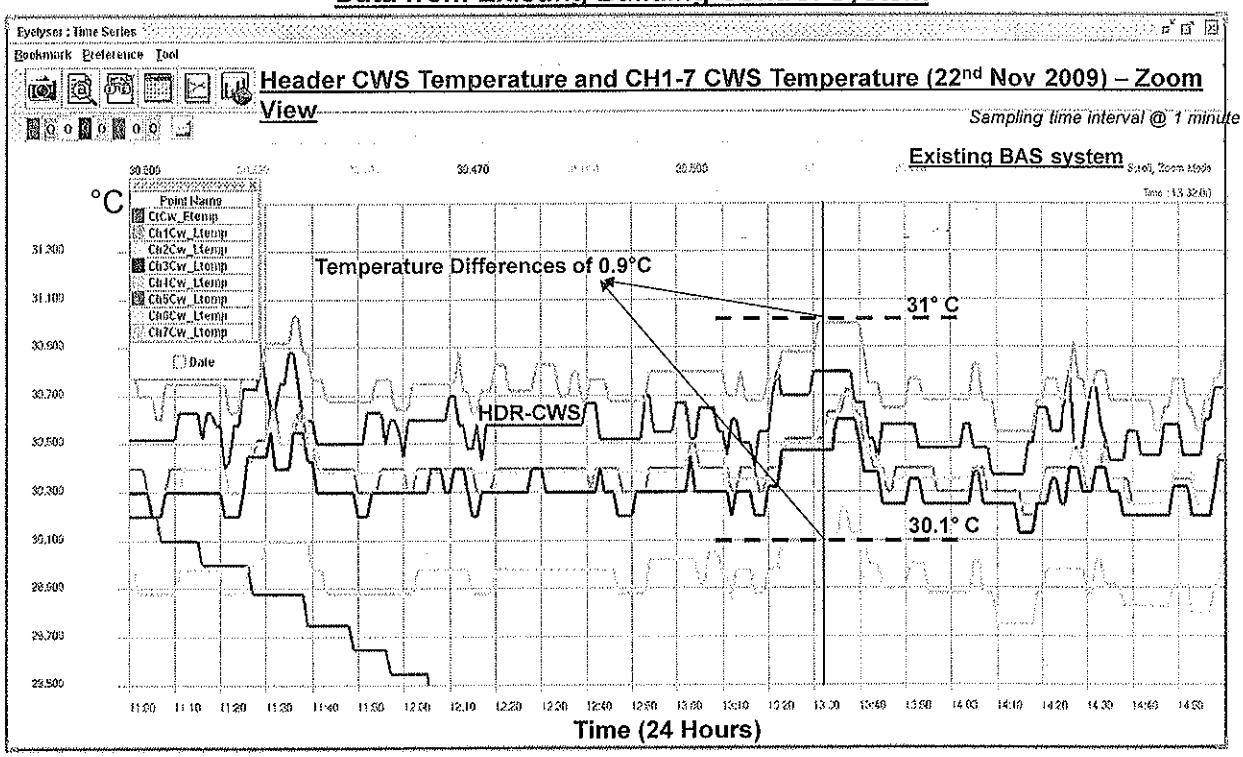
BAS and EMS

Data from Existing Building Control System



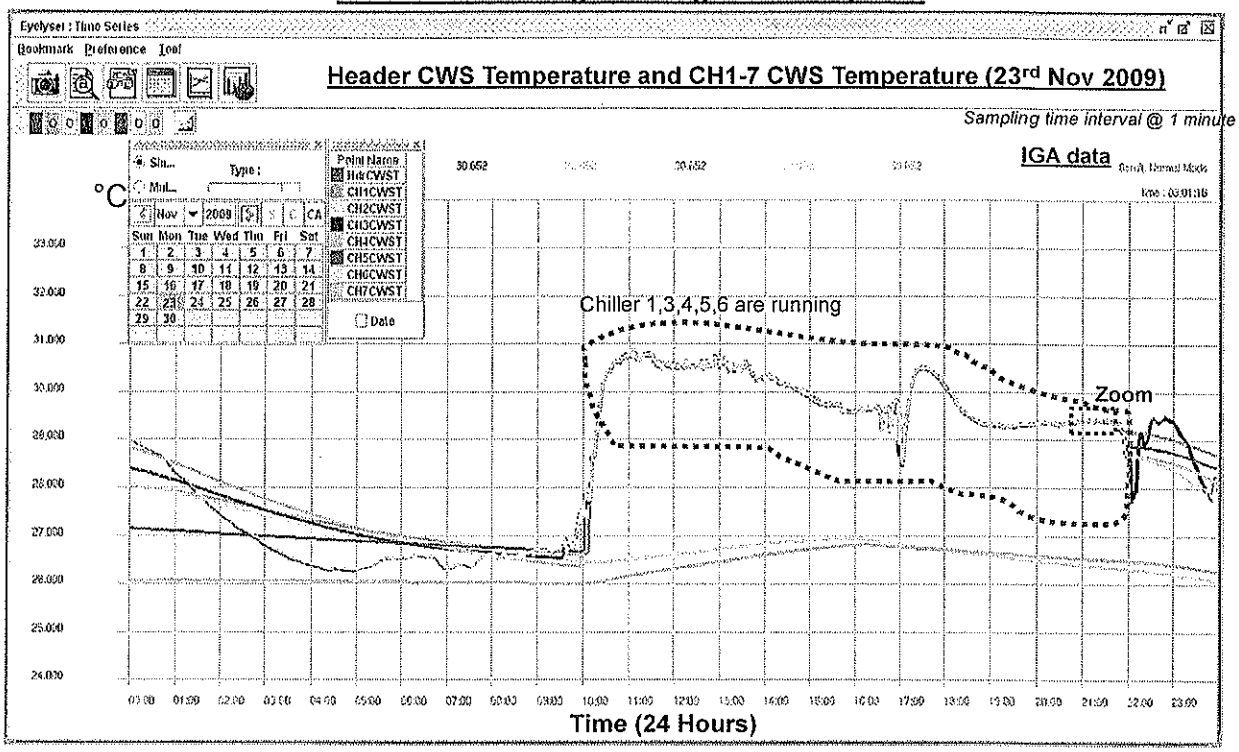
BAS and EMS

Data from Existing Building Control System



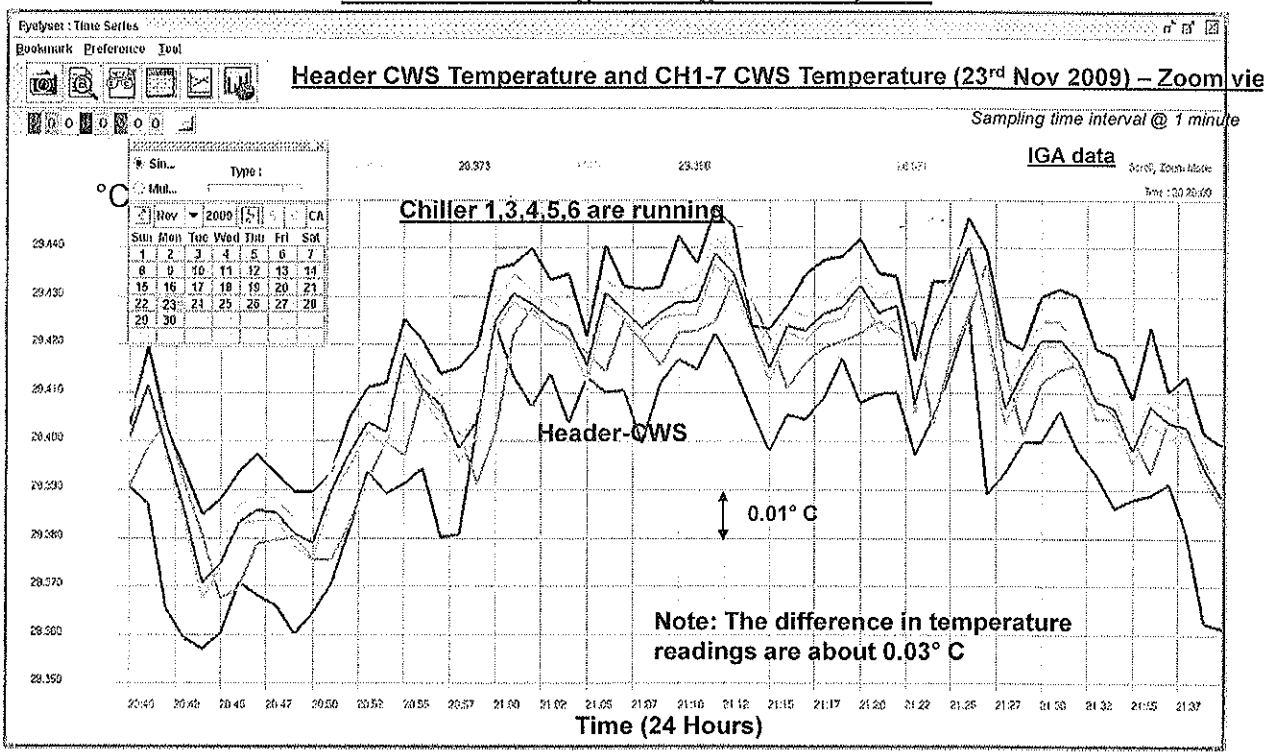
BAS and EMS

Data from Existing Building Control System



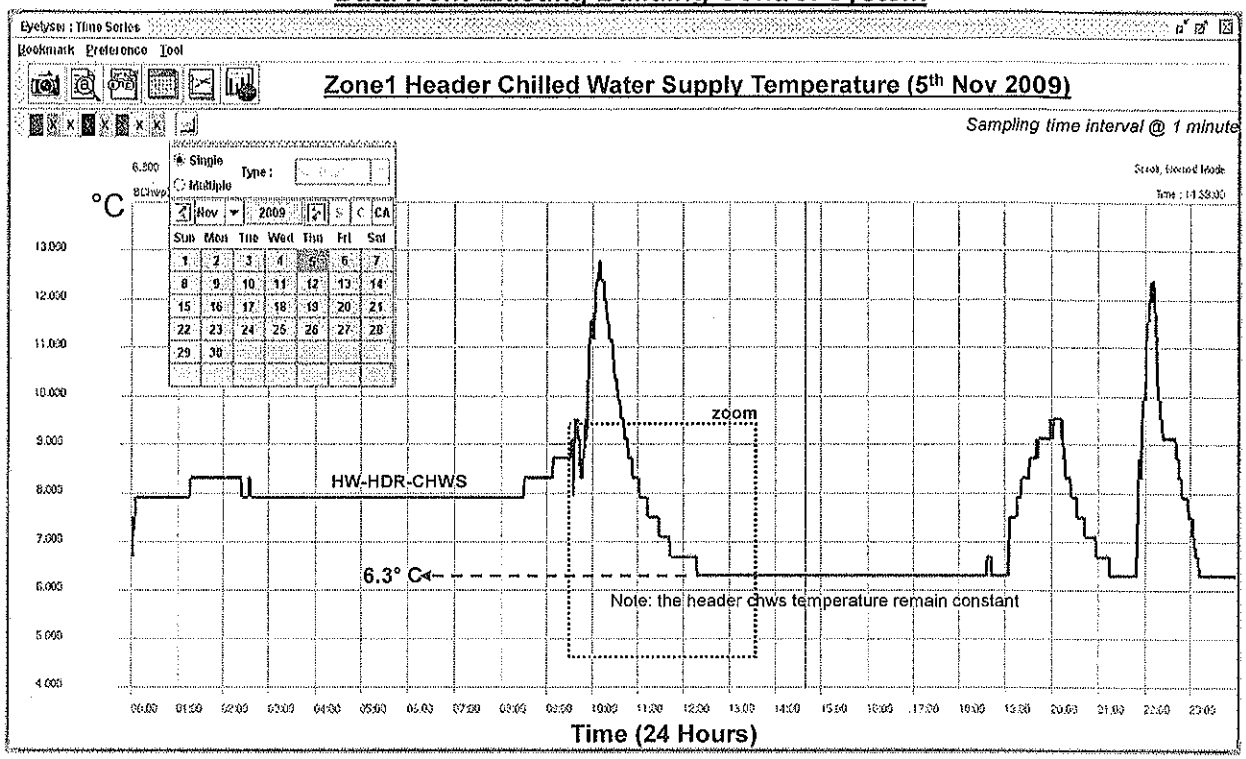
BAS and EMS

Data from Existing Building Control System



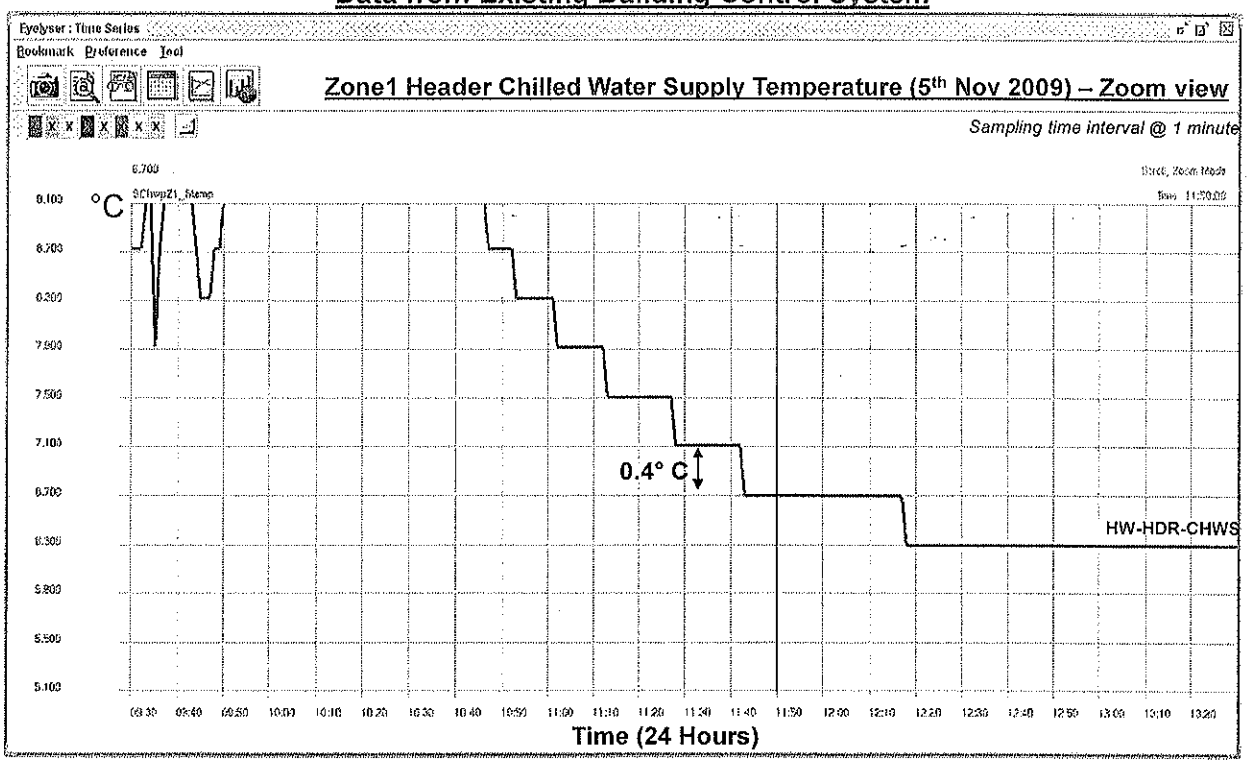
BAS and EMS

Data from Existing Building Control System



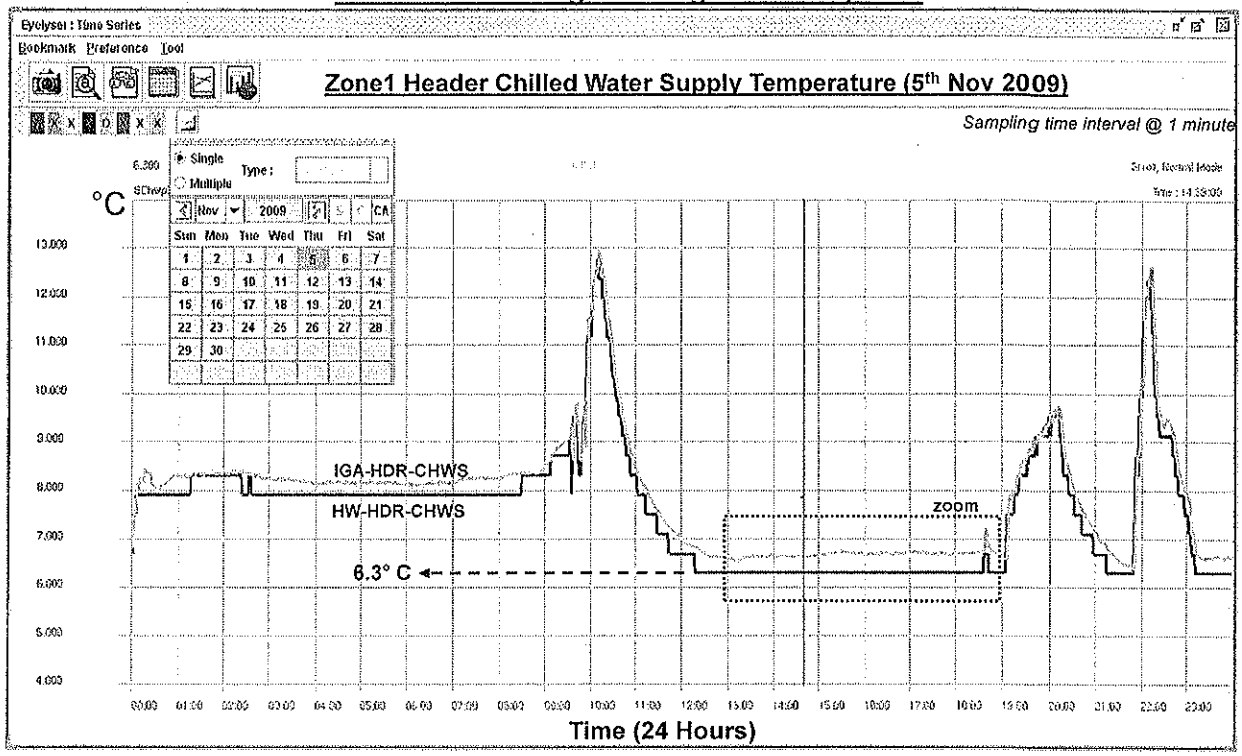
BAS and EMS

Data from Existing Building Control System



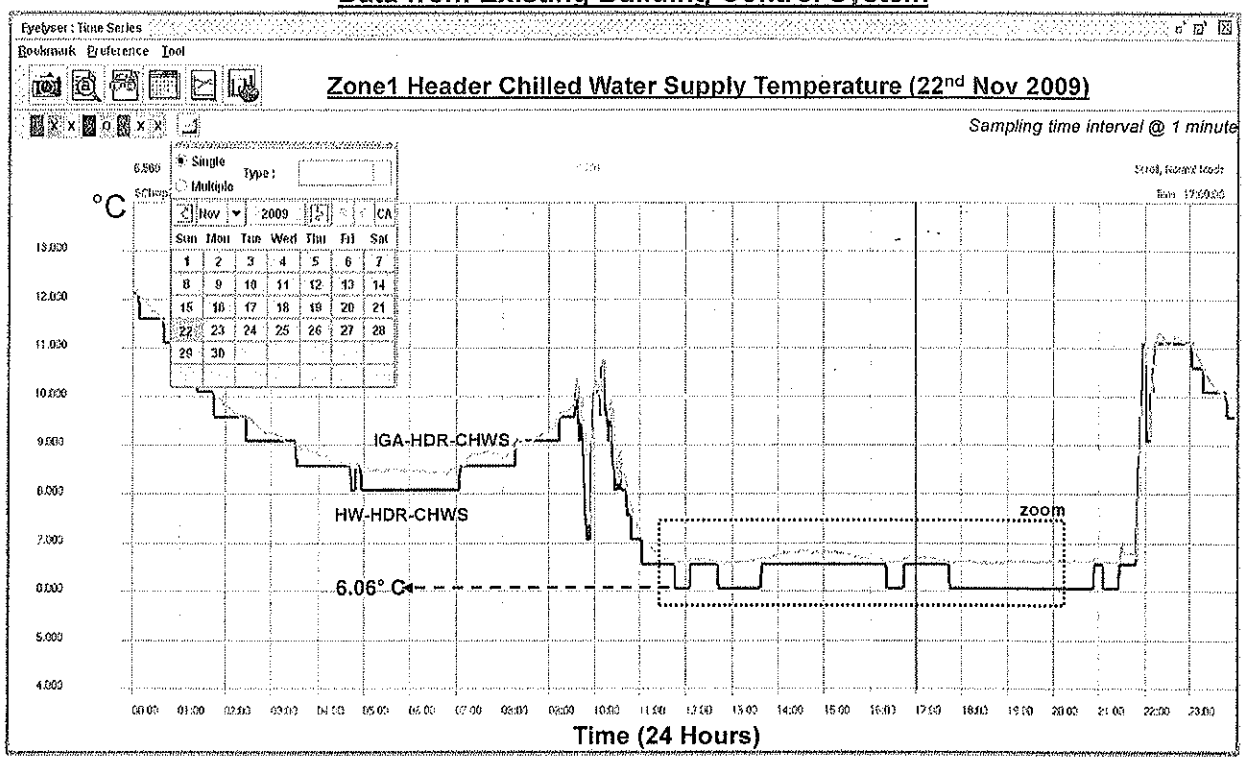
BAS and EMS

Data from Existing Building Control System



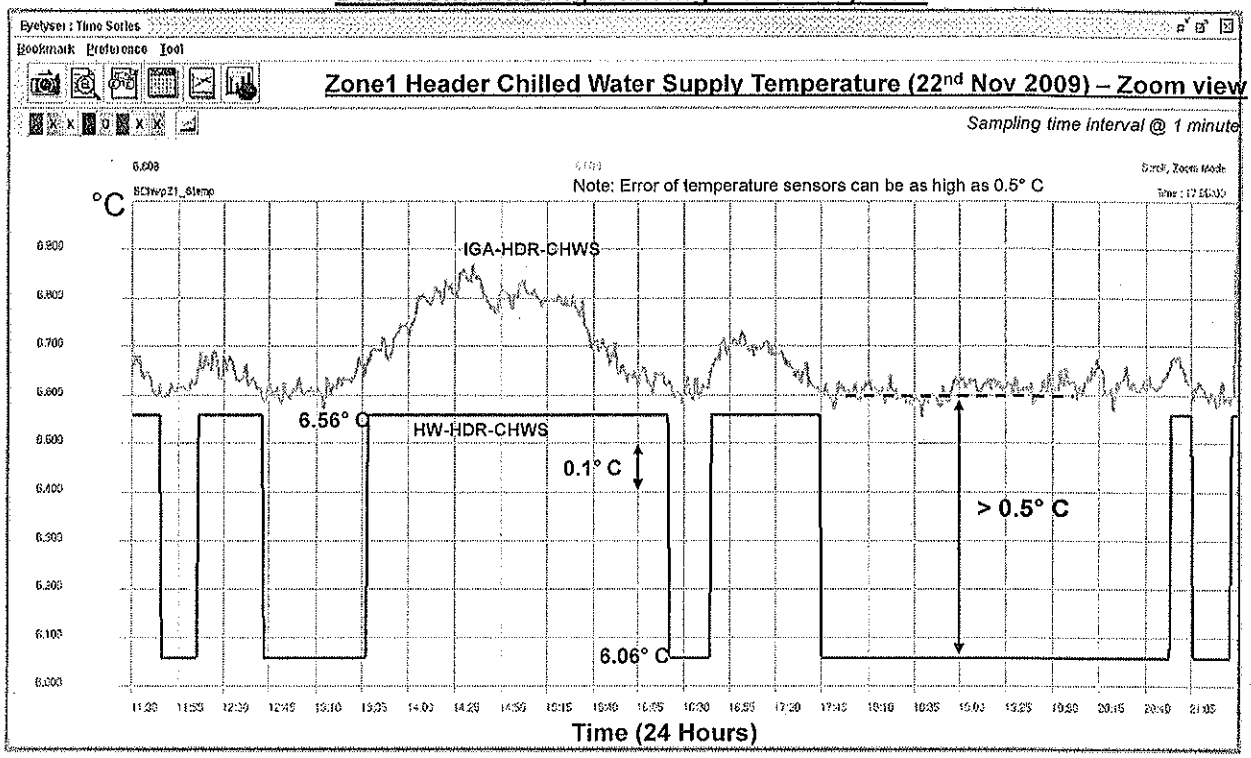
BAS and EMS

Data from Existing Building Control System



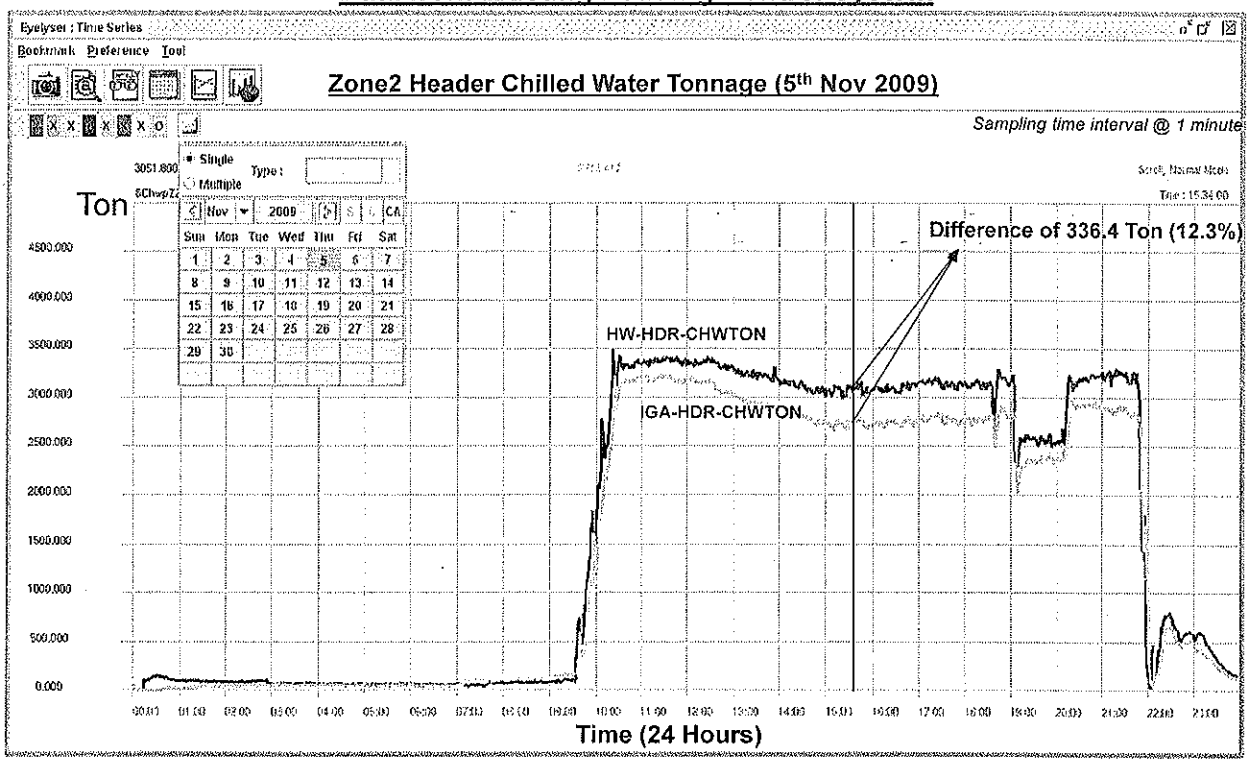
BAS and EMS

Data from Existing Building Control System



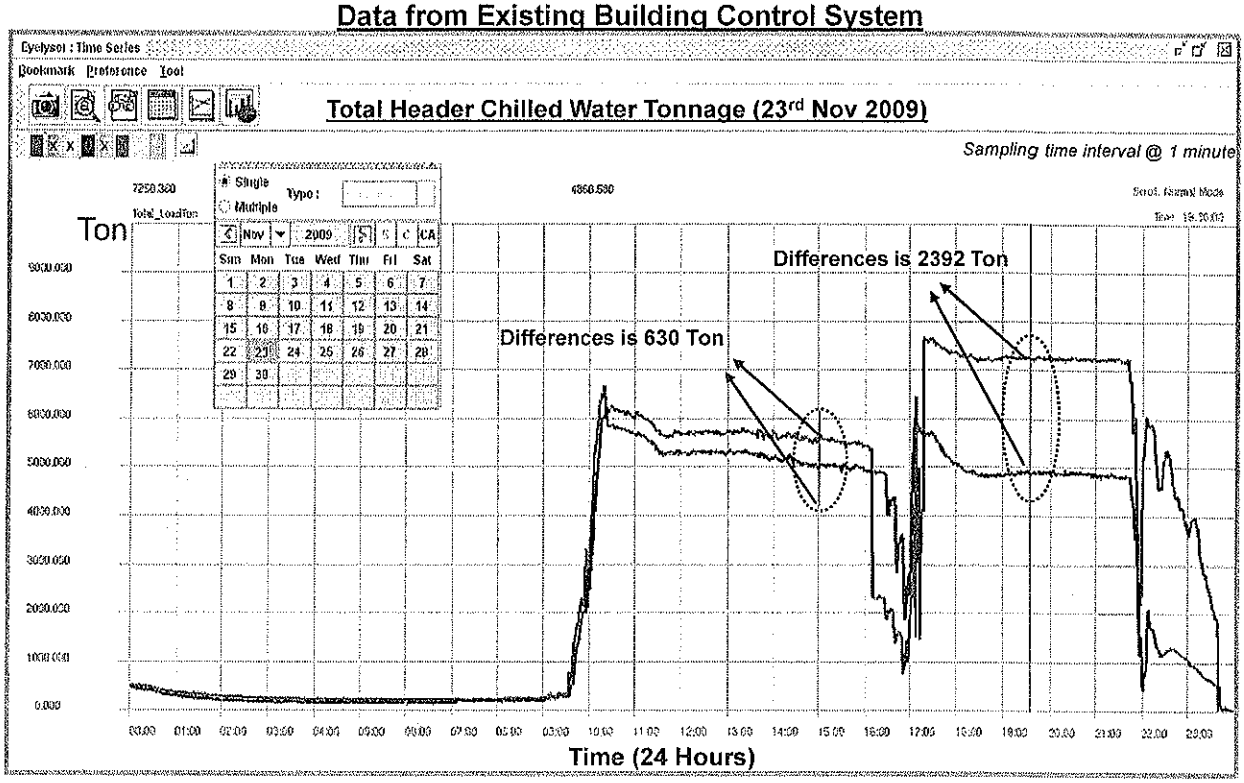
BAS and EMS

Data from Existing Building Control System



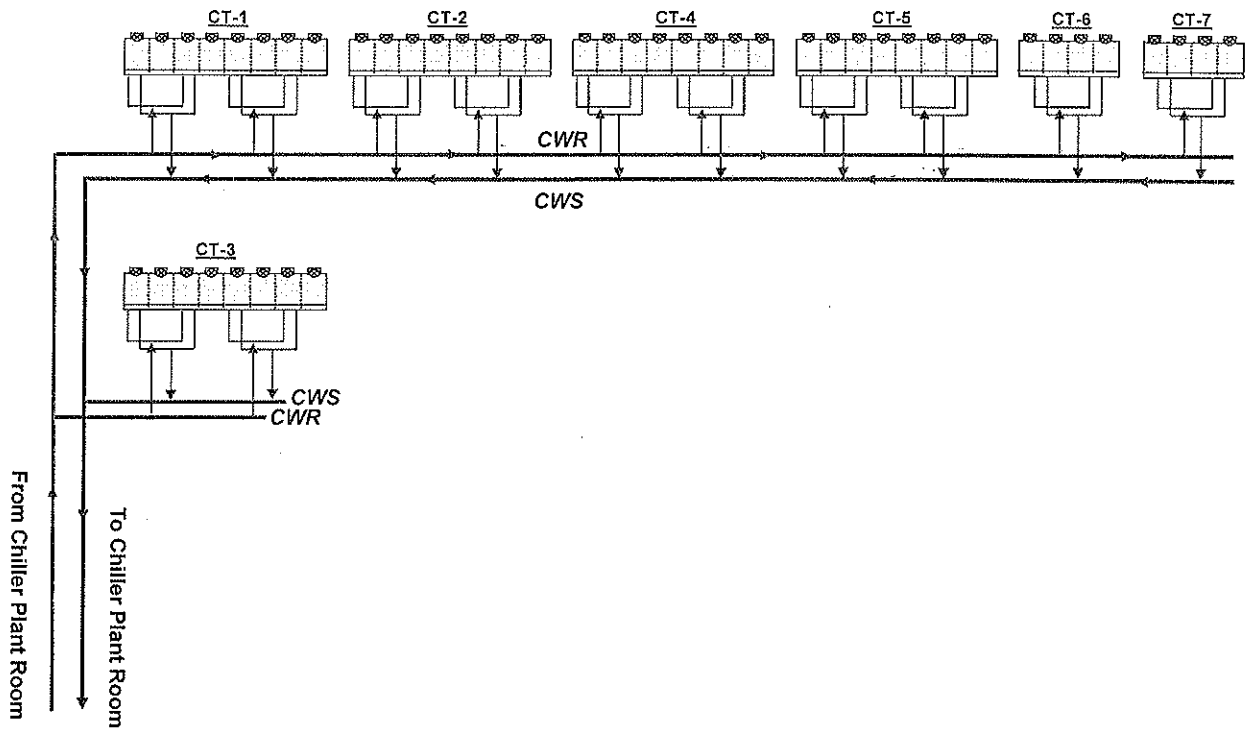
BAS and EMS

Data from Existing Building Control System



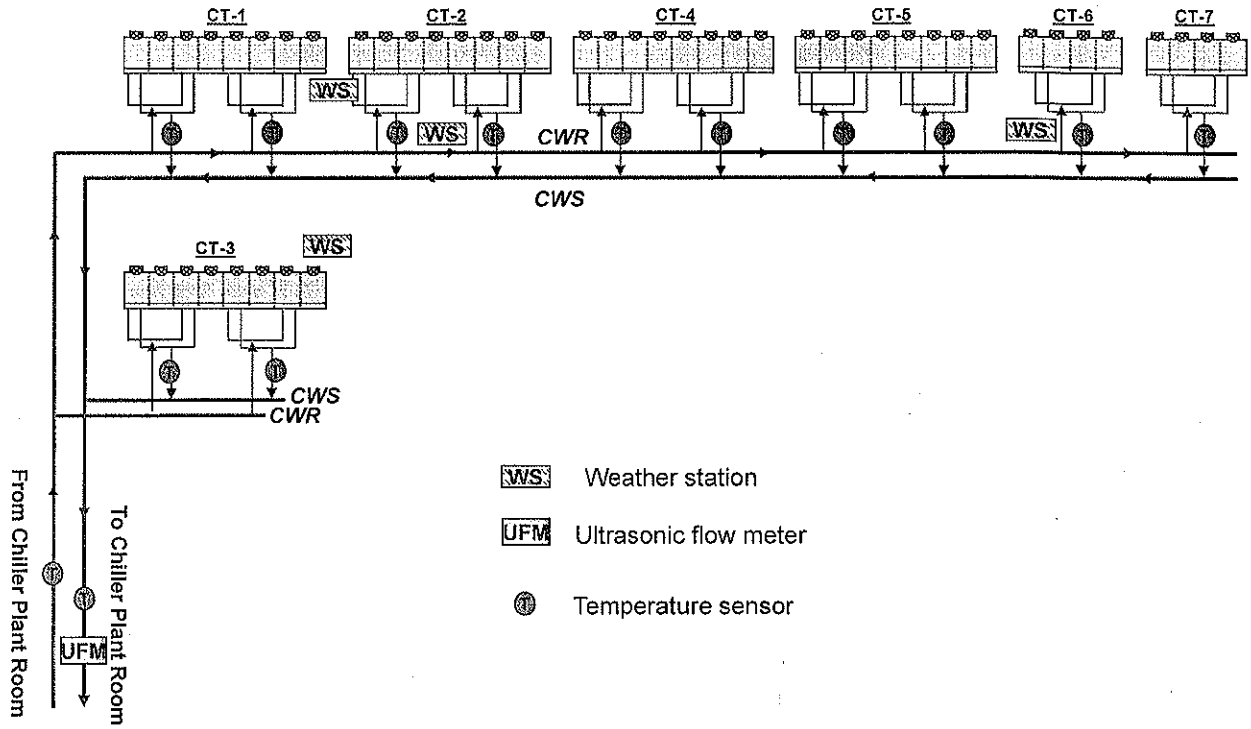
Cooling Tower

Schematic of Cooling Tower

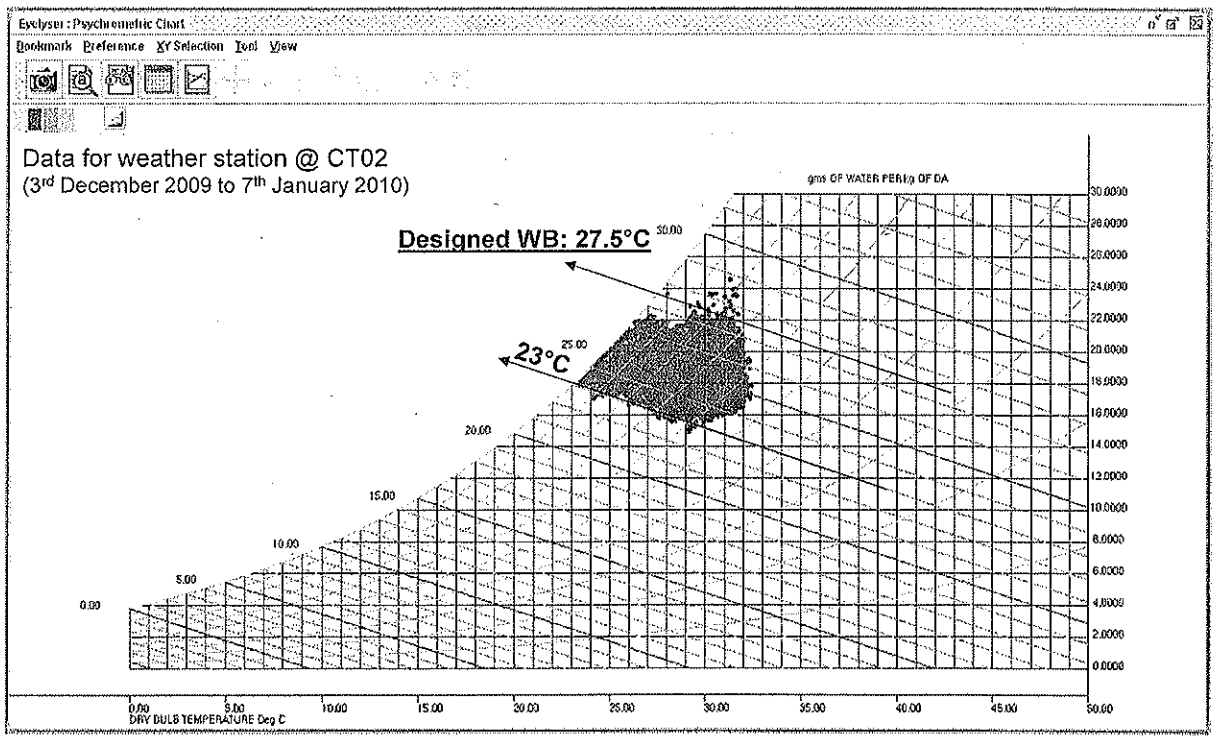


Cooling Tower

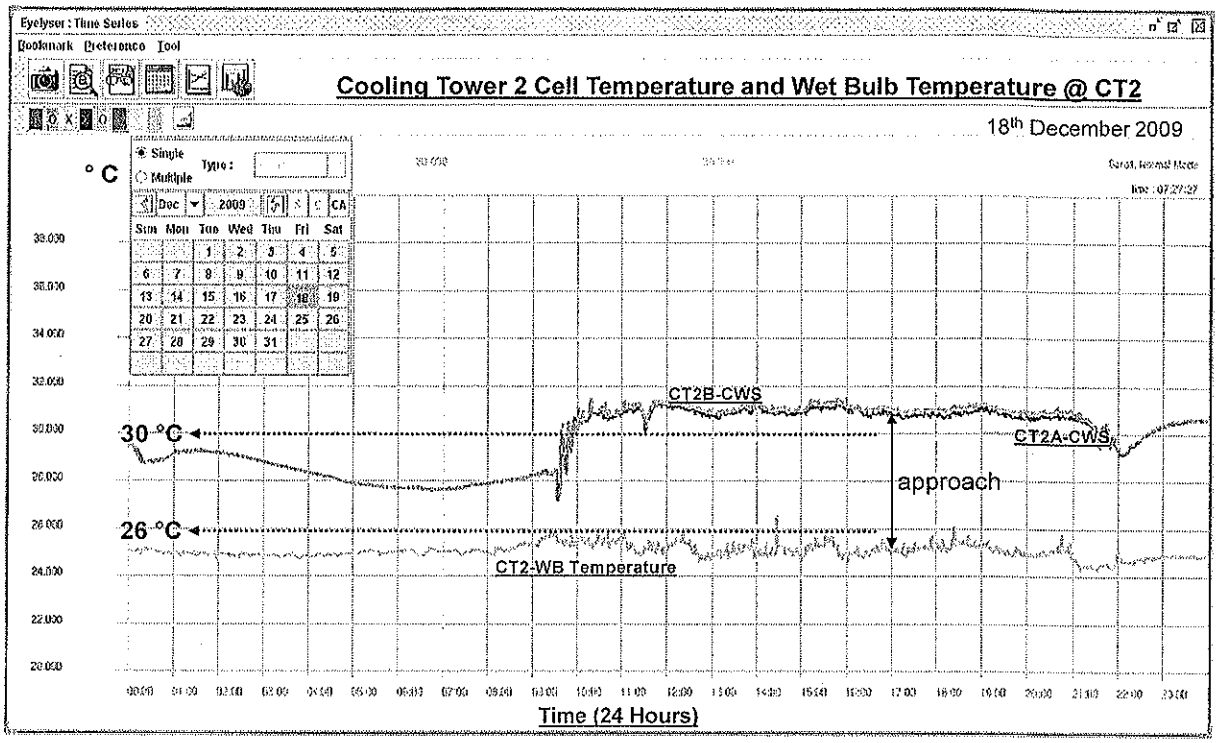
Schematic of Cooling Tower



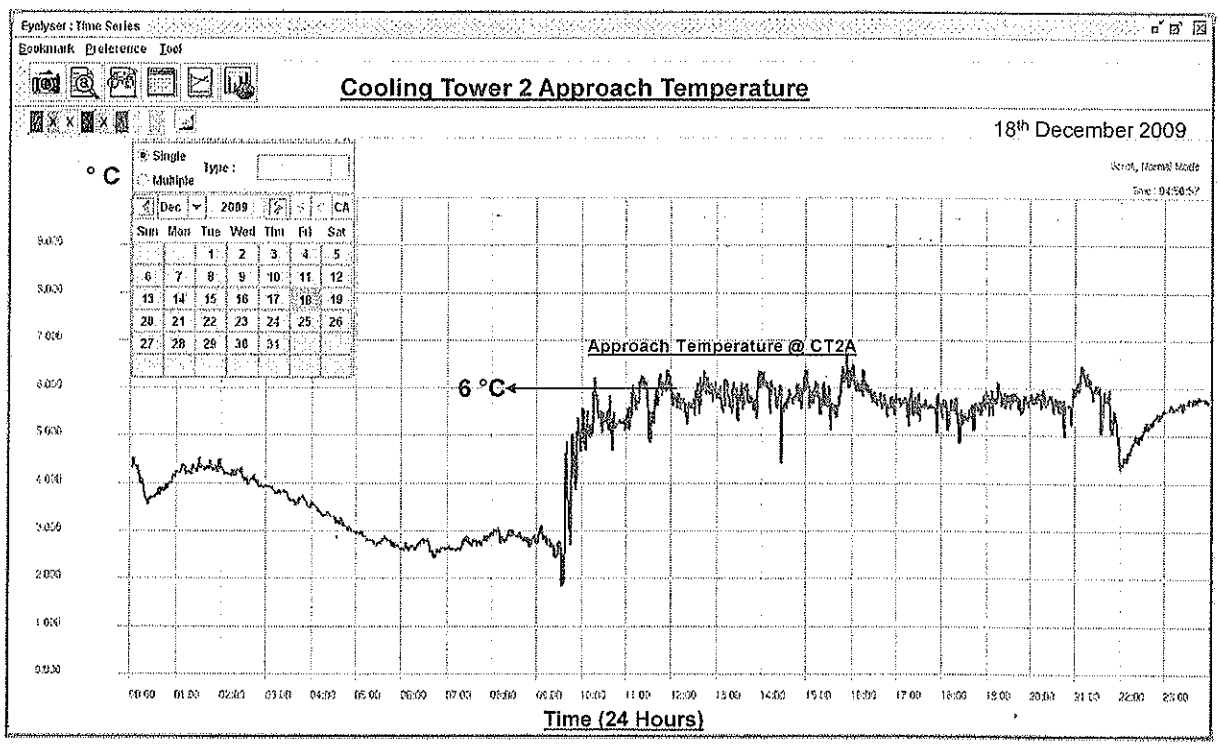
Cooling Tower



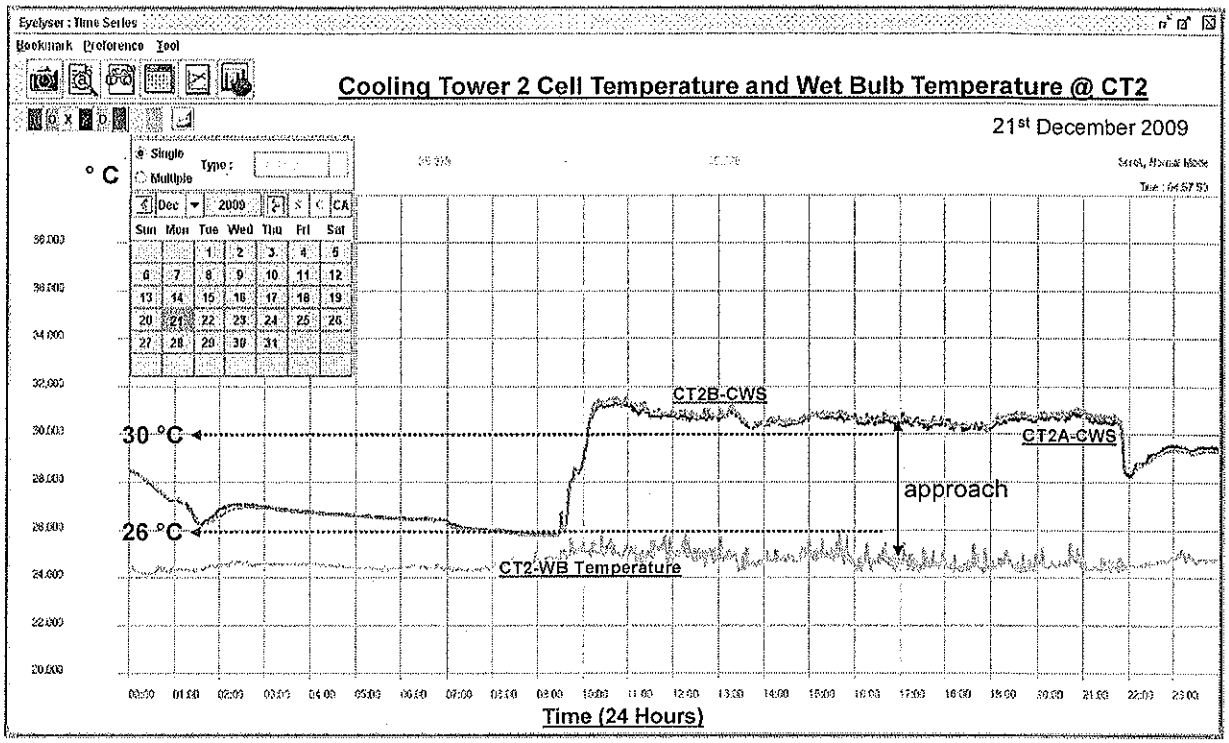
Cooling Tower



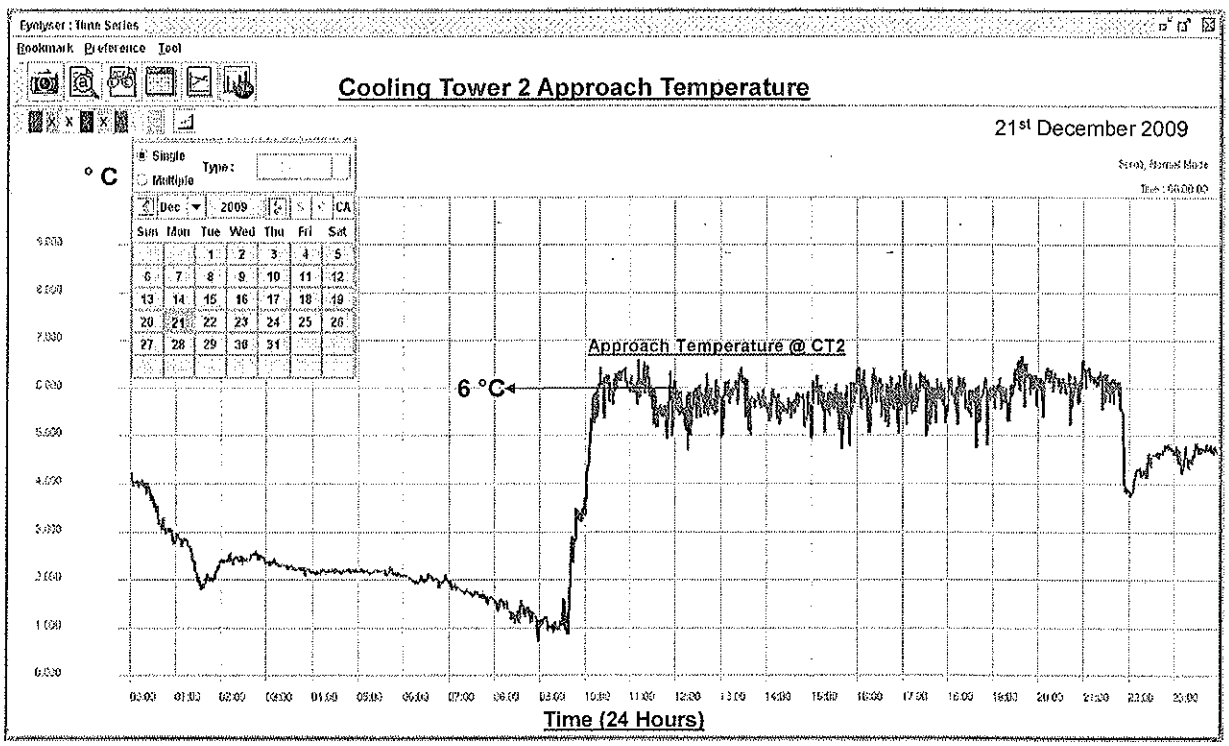
Cooling Tower



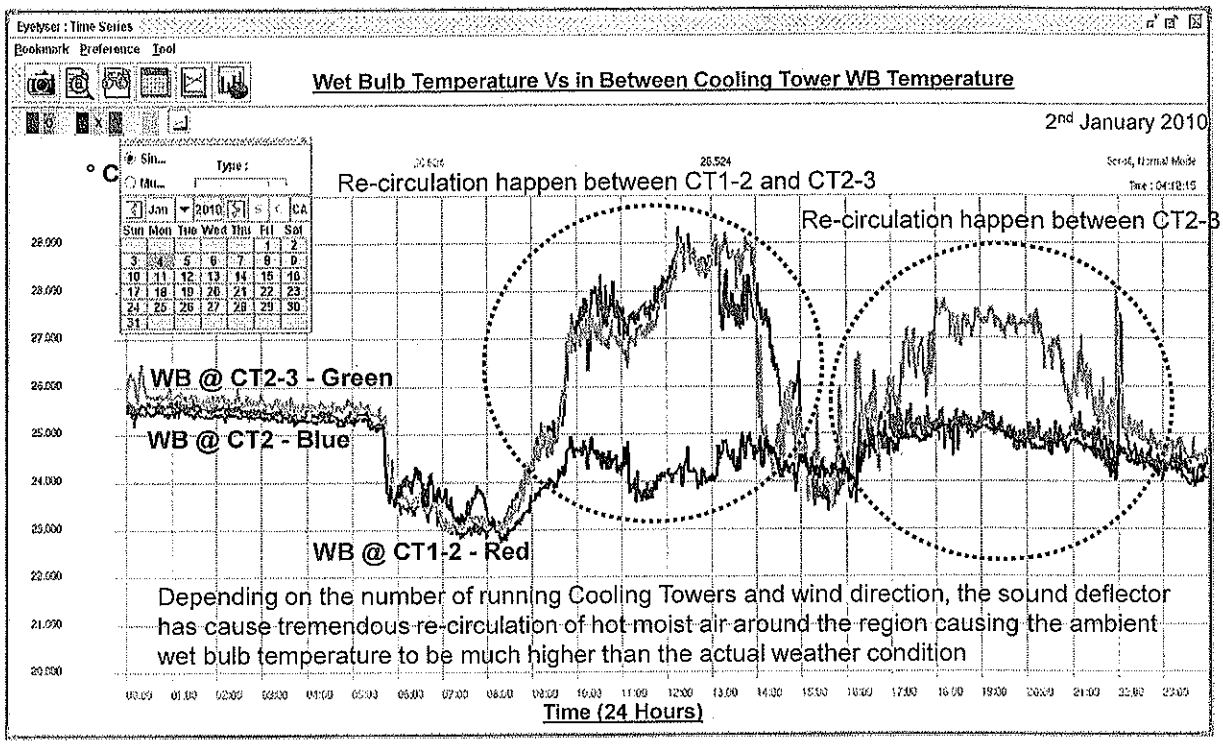
Cooling Tower

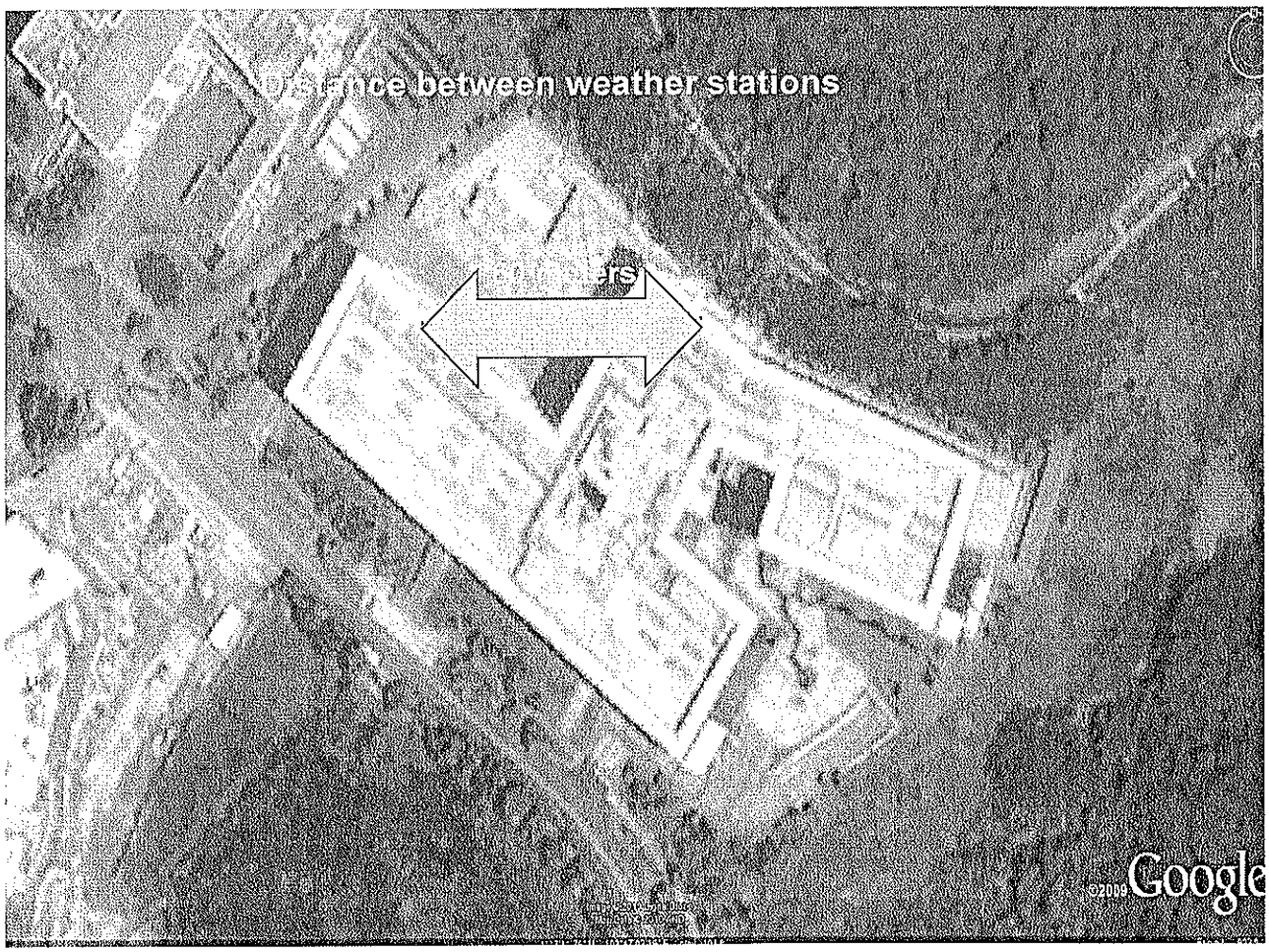


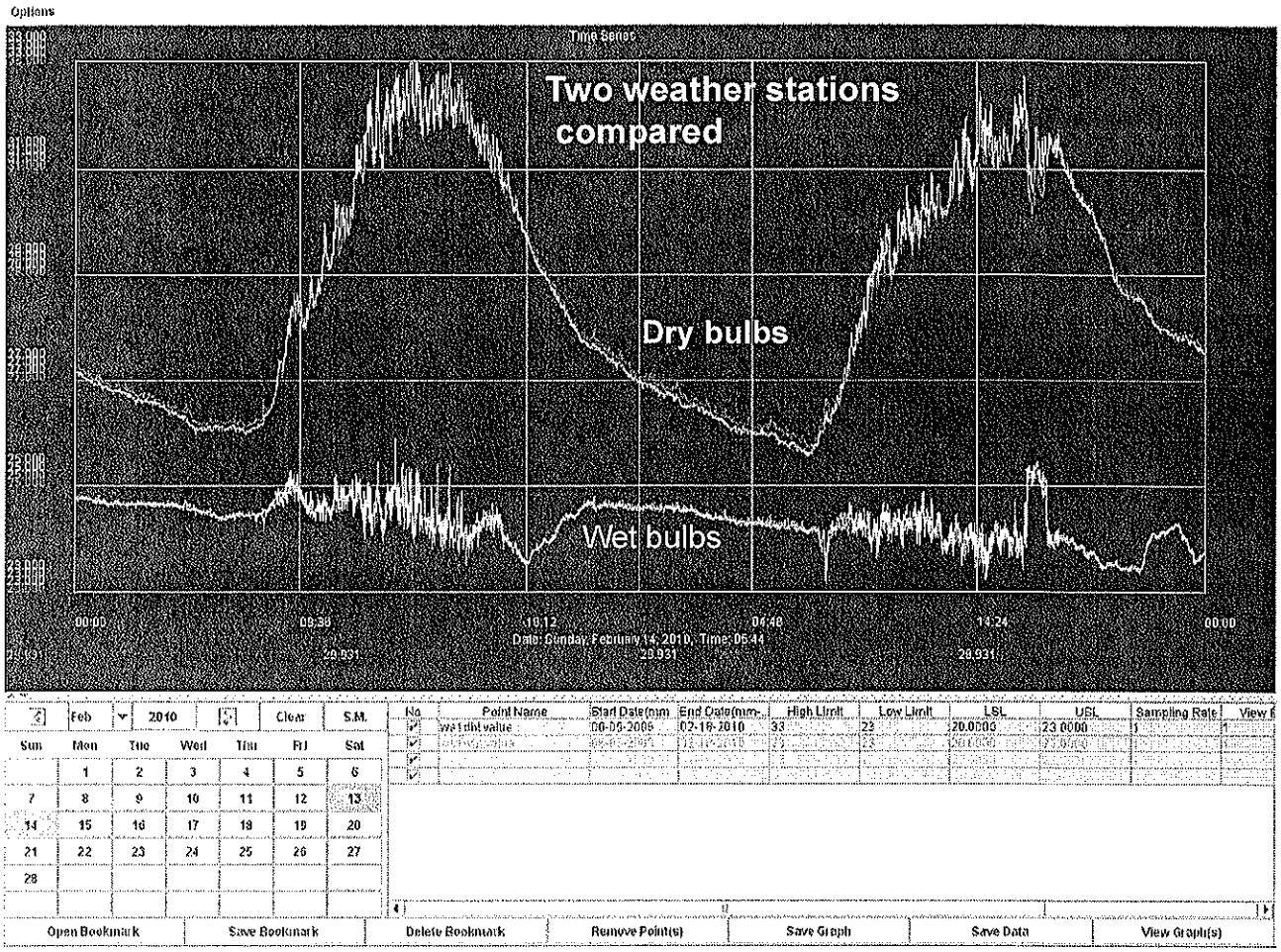
Cooling Tower

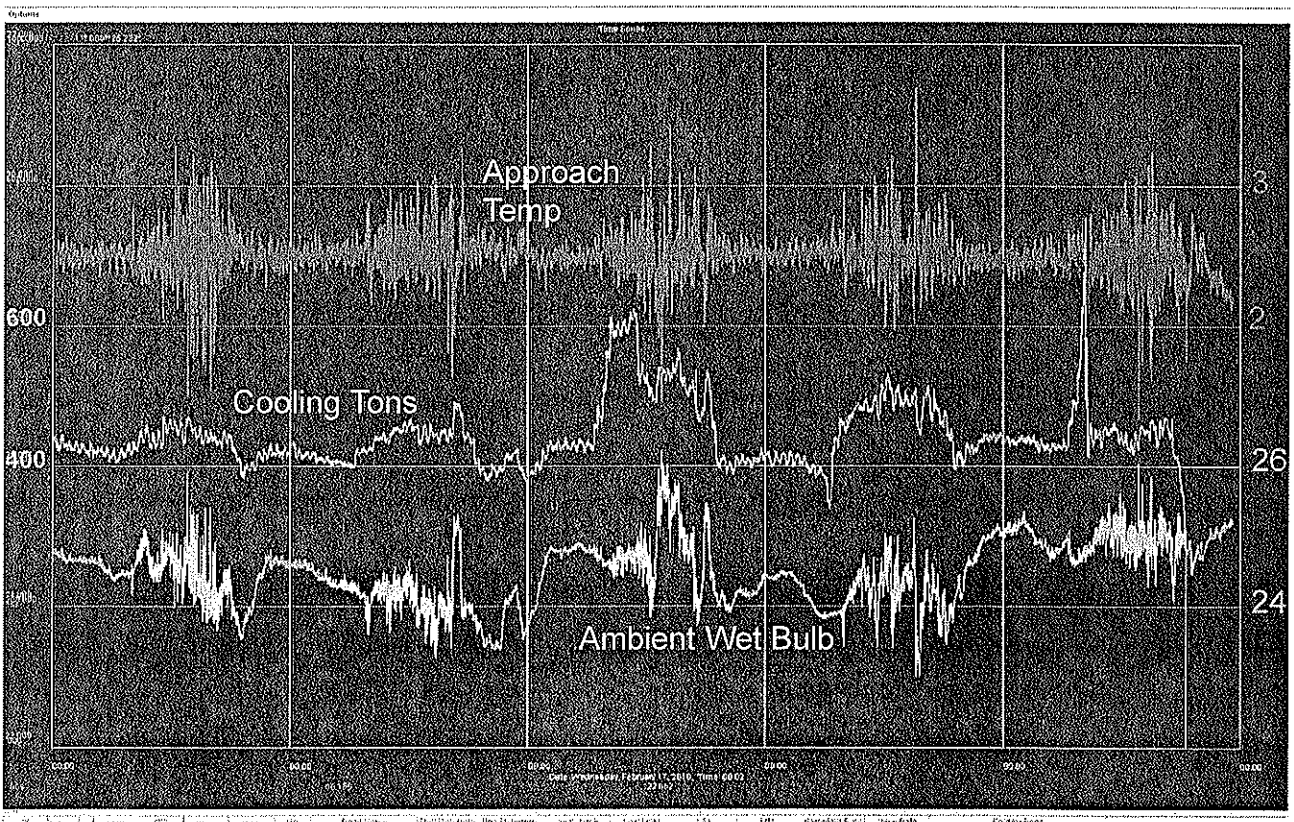


Cooling Tower

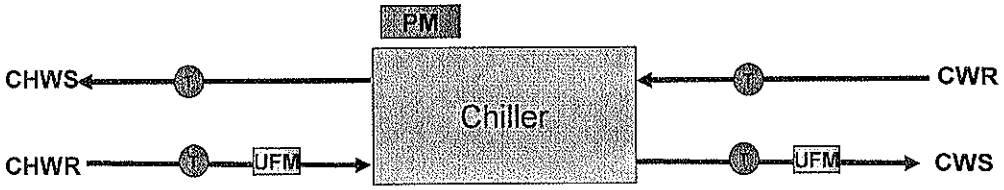





Options
Time Series
Two weather stations compared
Dry bulbs
Wet bulbs
00:00
08:38
19:12
04:48
14:24
00:00
Date: Sunday, February 14, 2010 Time: 05:44
29.931
29.931
29.931
Feb
2010
Clear
S.M.
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28
No.
Point Name
Start Date(mm
End Date(mm-
High Limit
Low Limit
LSL
USL
Sampling Rate
wet bulb value
02-18-2010
33
23
23.0000
Open Bookmark
Save Bookmark
Delete Bookmark
Remove Point(s)
Save Graph
Save Data
View Graph(s)


Approach Temp
Cooling Tons
Ambient Wet Bulb
600
400
3
2
26
24

Chillers monitoring points



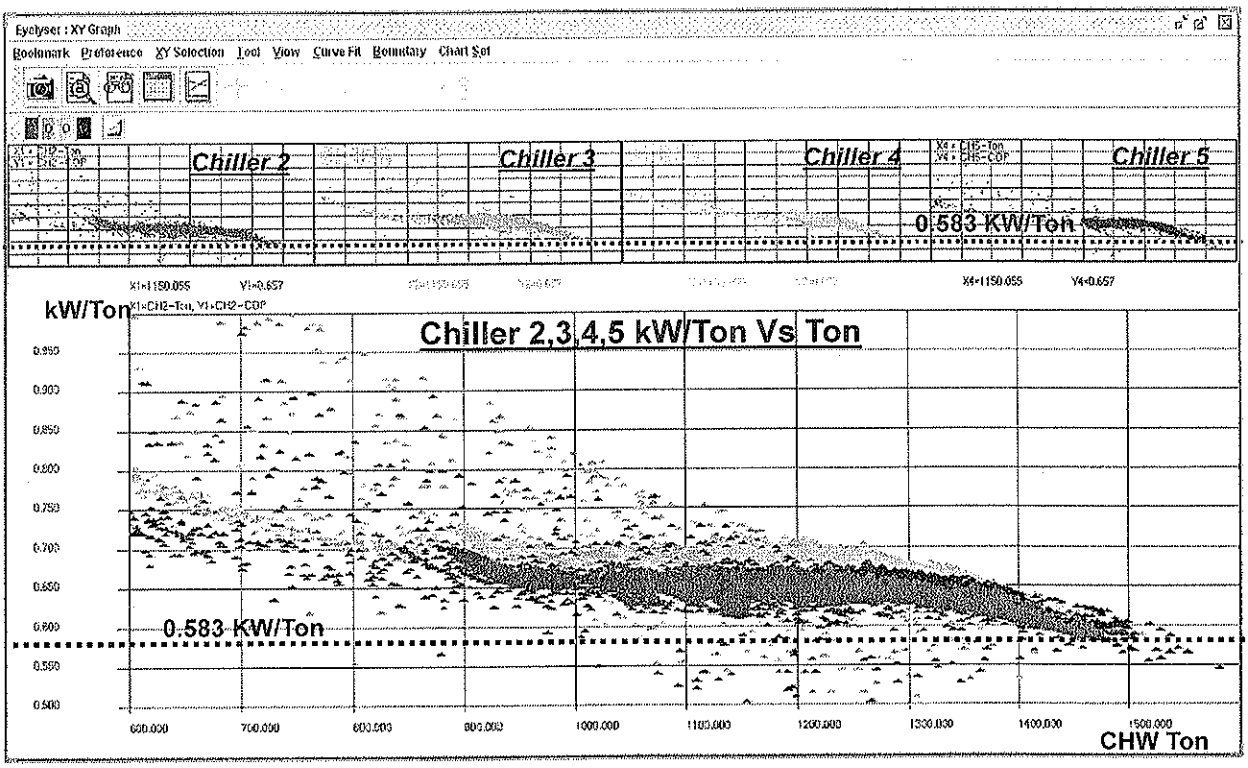
PM Existing power meter

UFM Ultrasonic flow meter

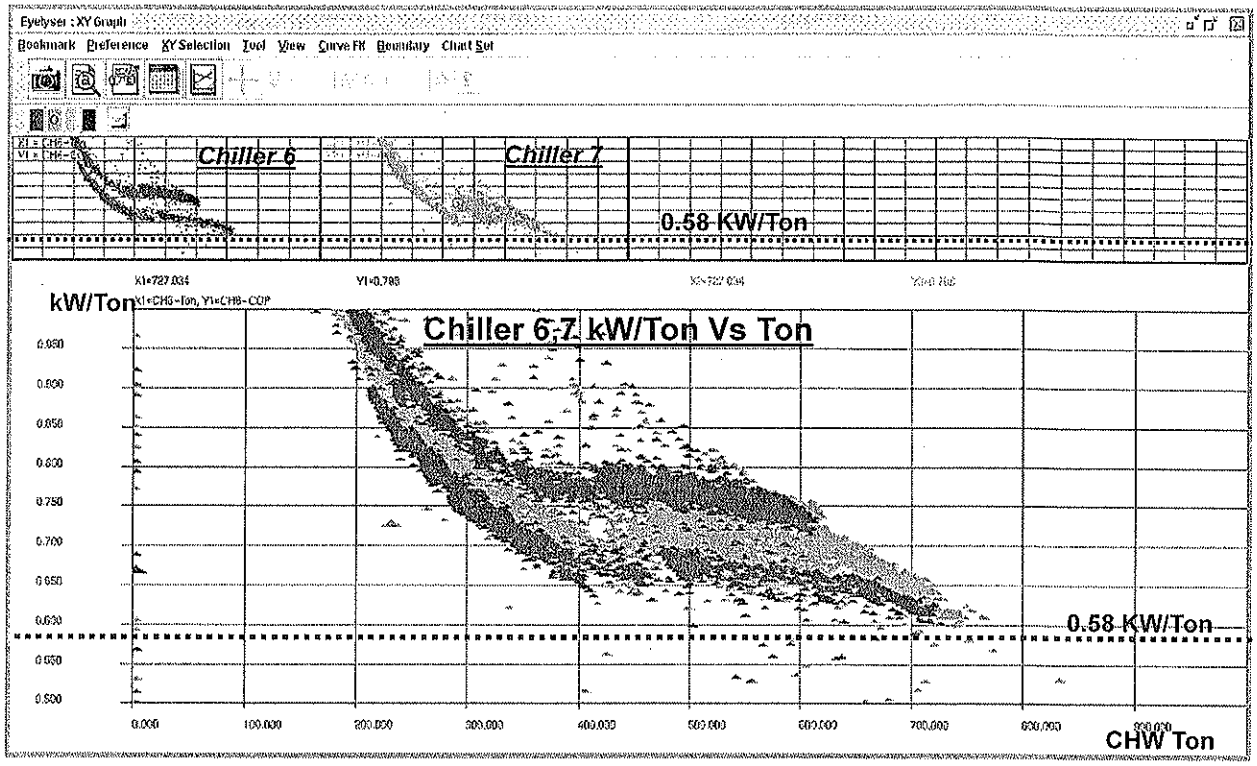
T Temperature sensor

CHW Ton = ΔT (CHWDT) X Flow (CHWFlow)
CW Ton = ΔT (CWDT) X Flow (CWFlow)
HB = (CW Ton – (CHW Ton + CHkW))/CHW Ton

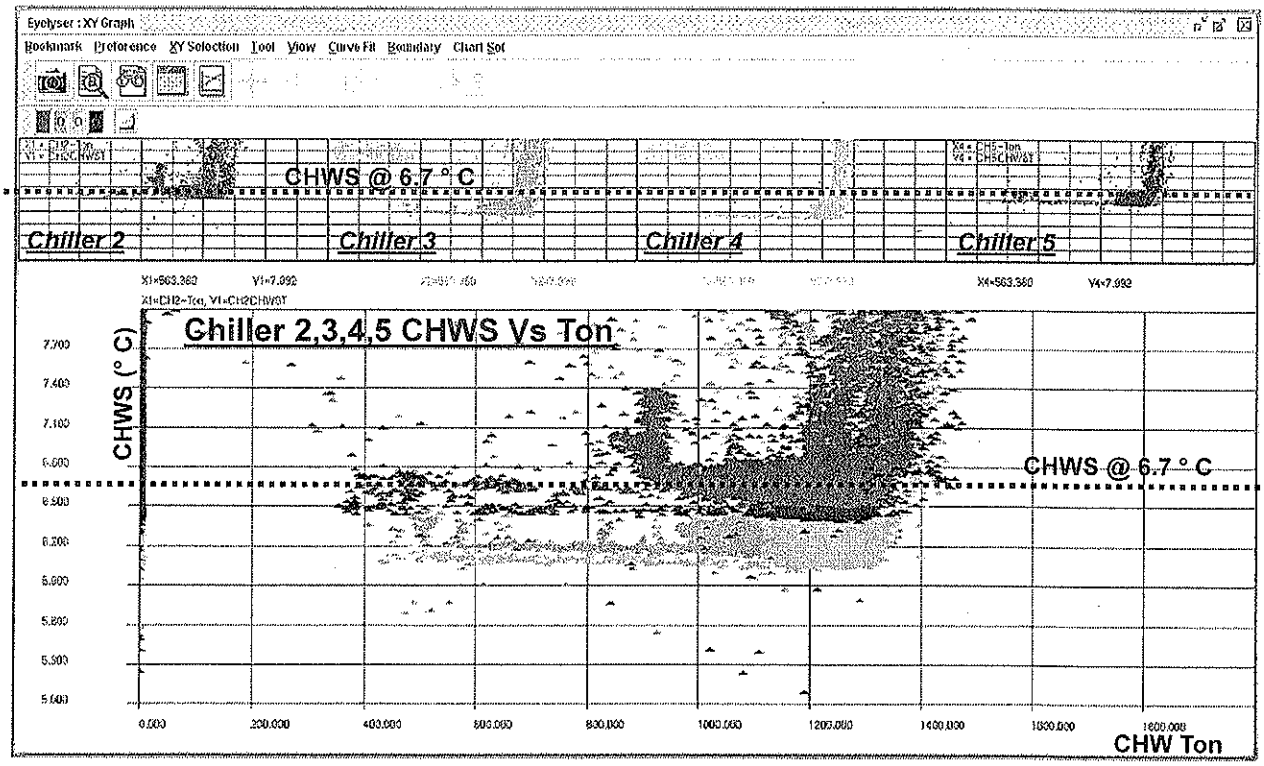
Chillers



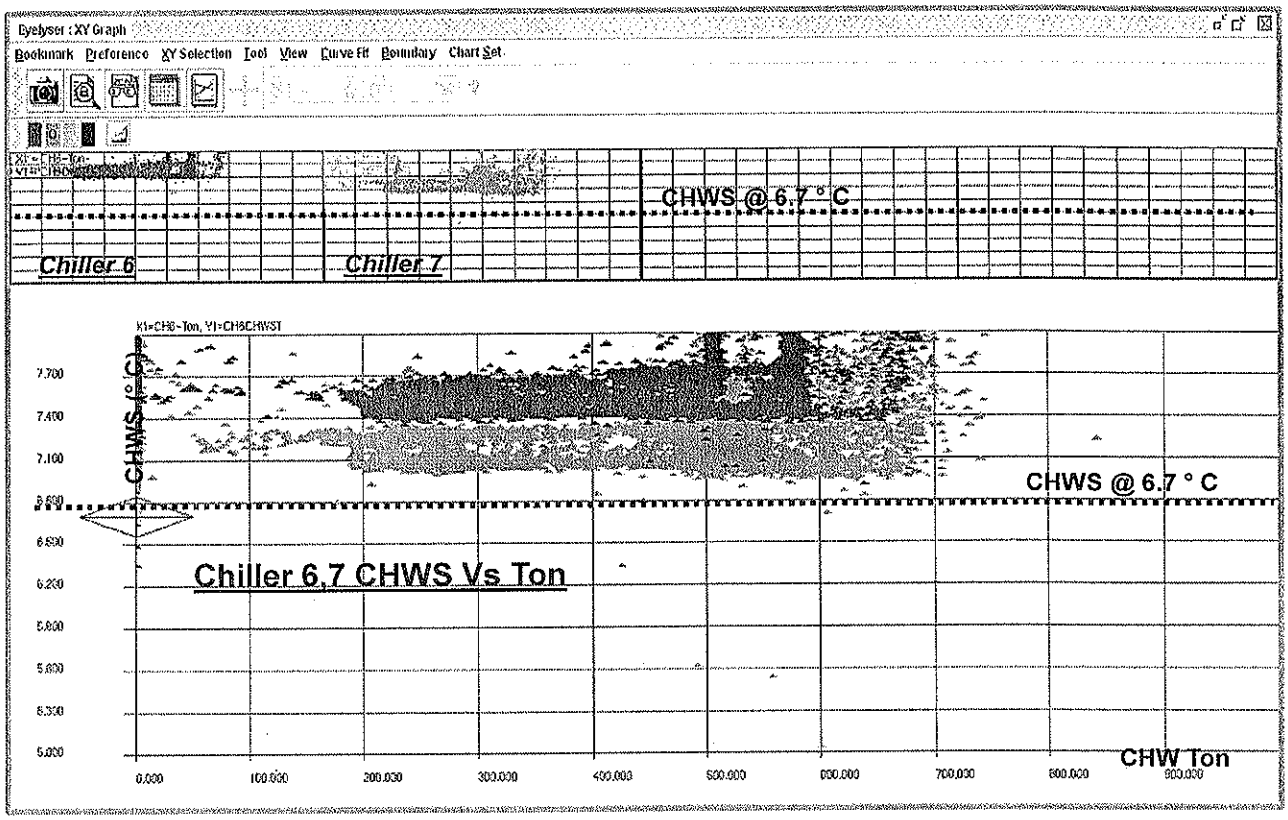
Chillers



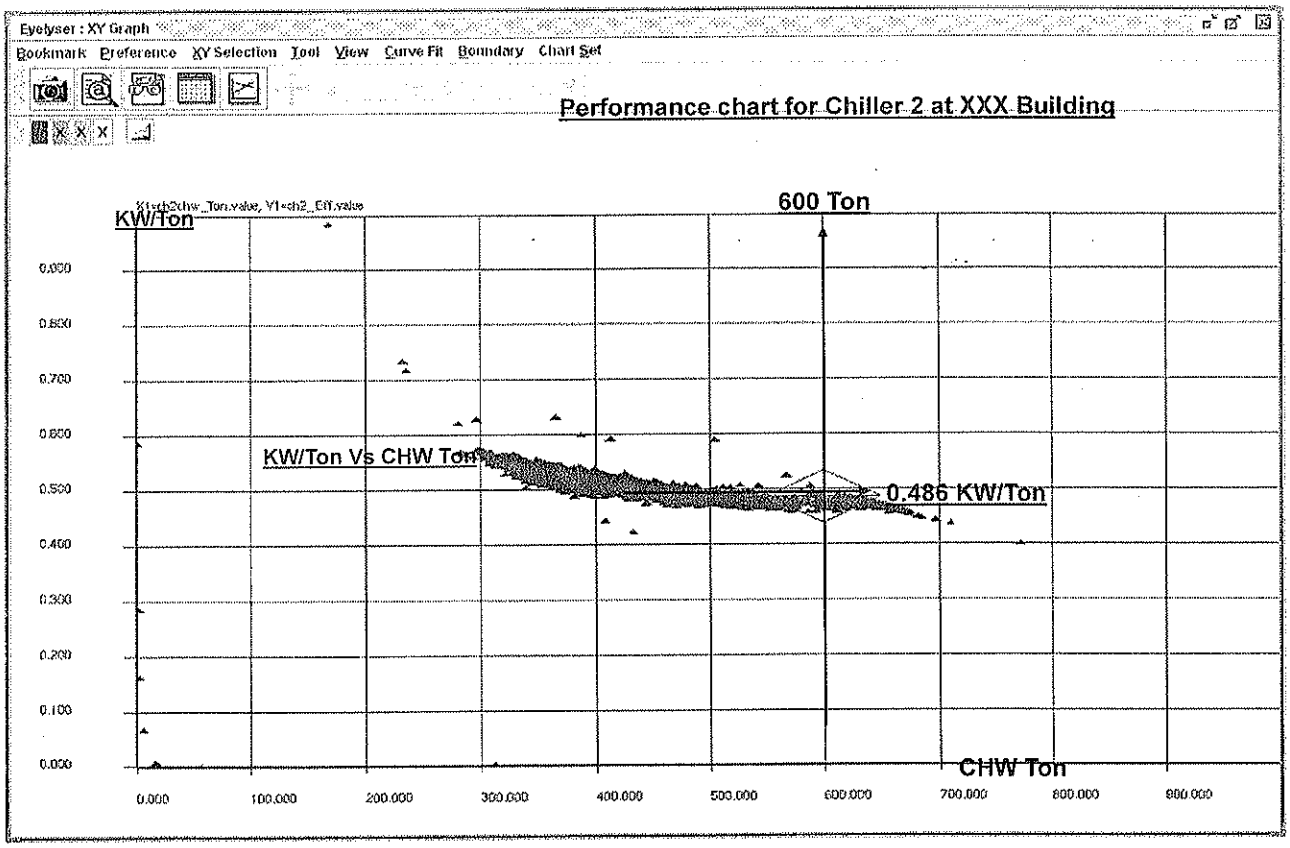
Chillers



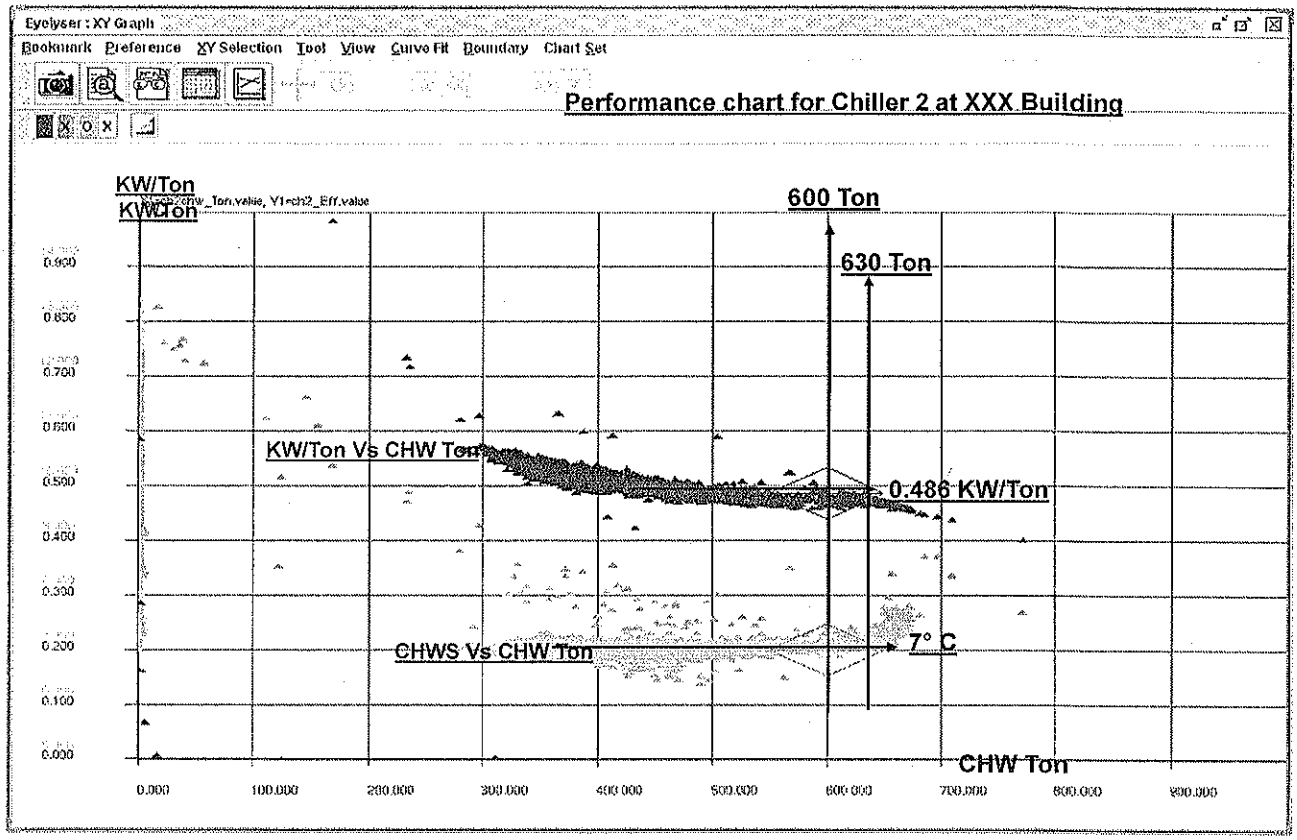
Chillers



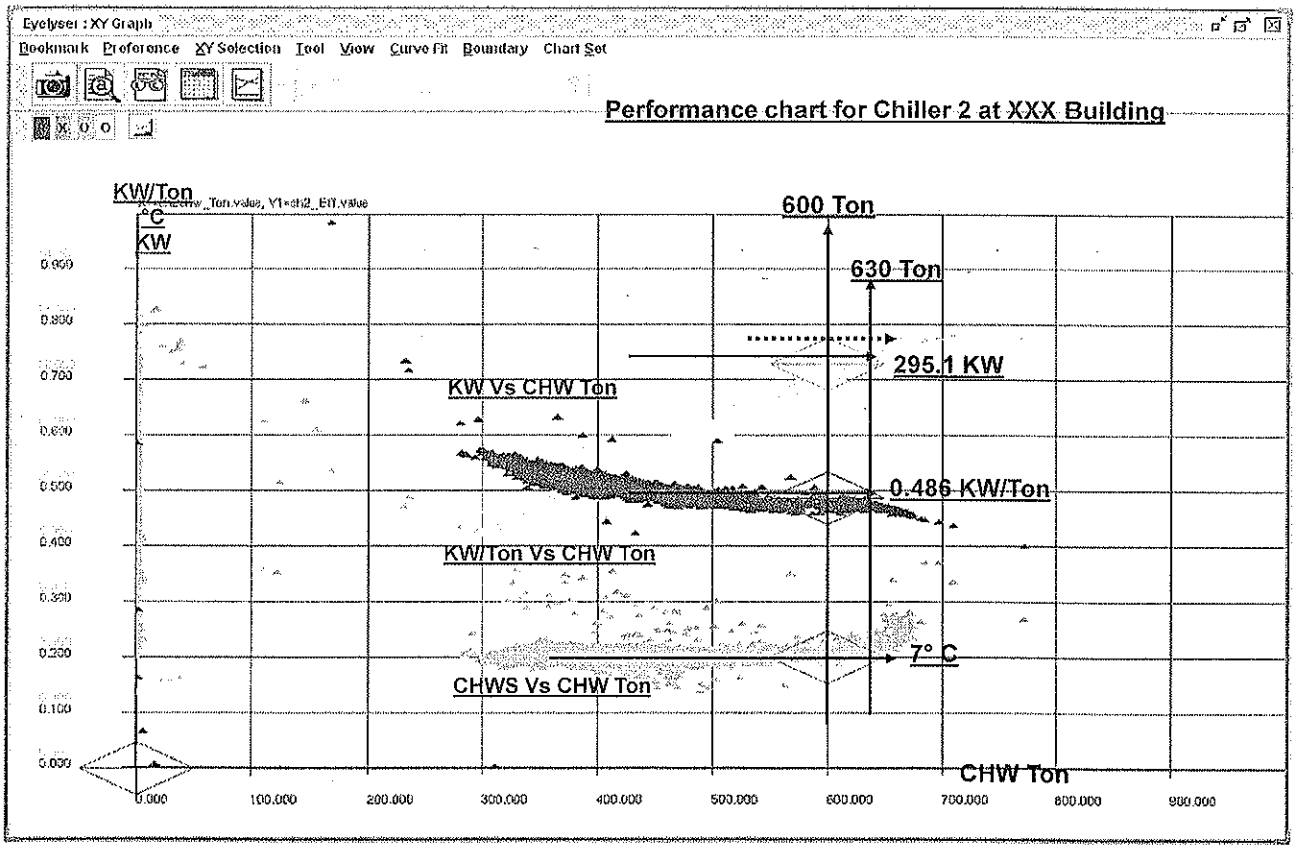
Retrofit Project Chillers



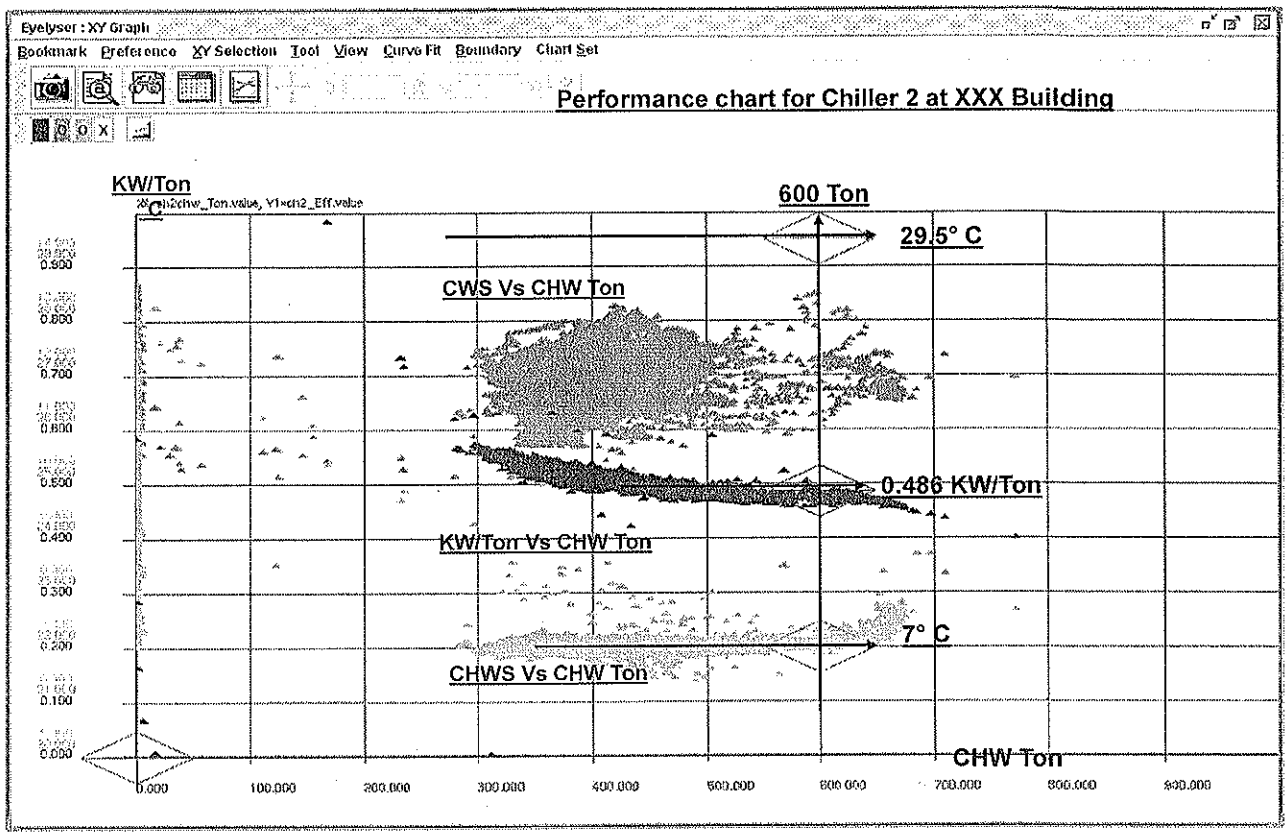
Retrofit Project Chillers



Retrofit Project Chillers

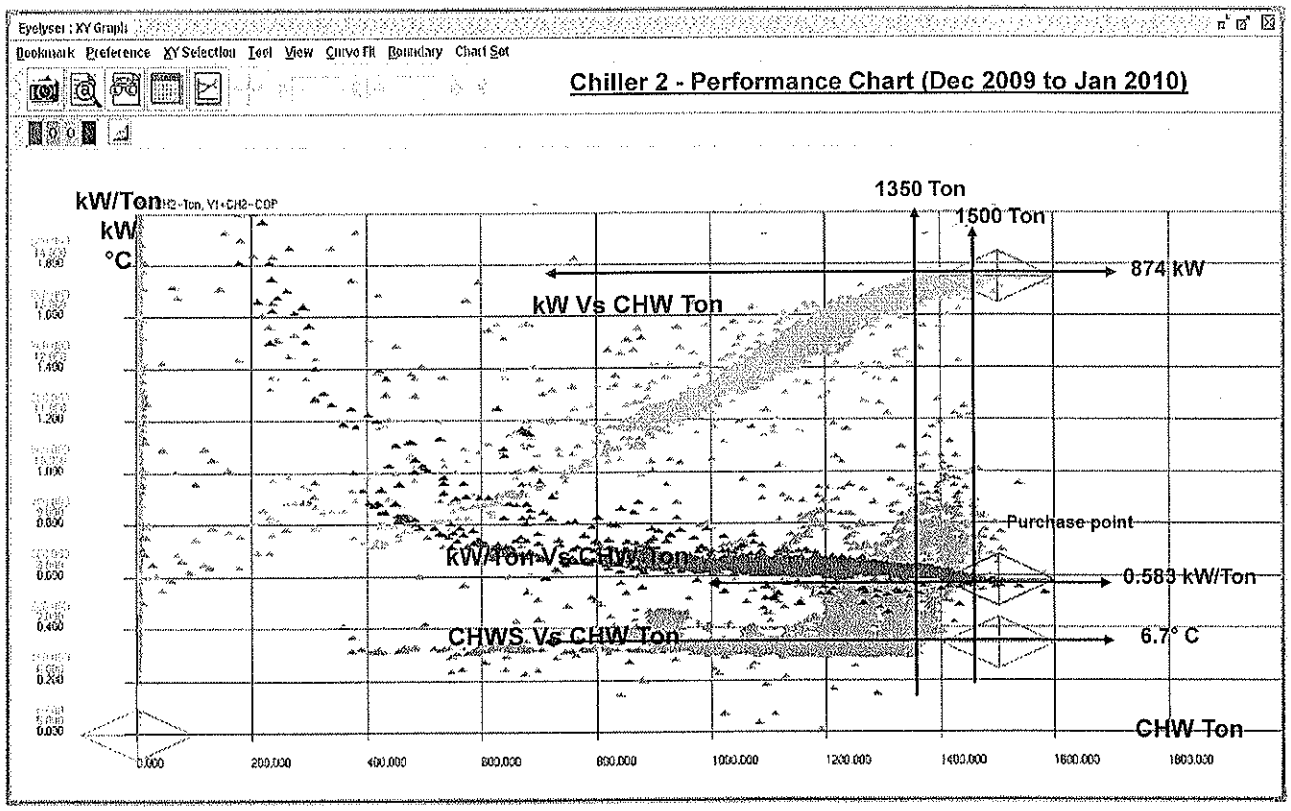


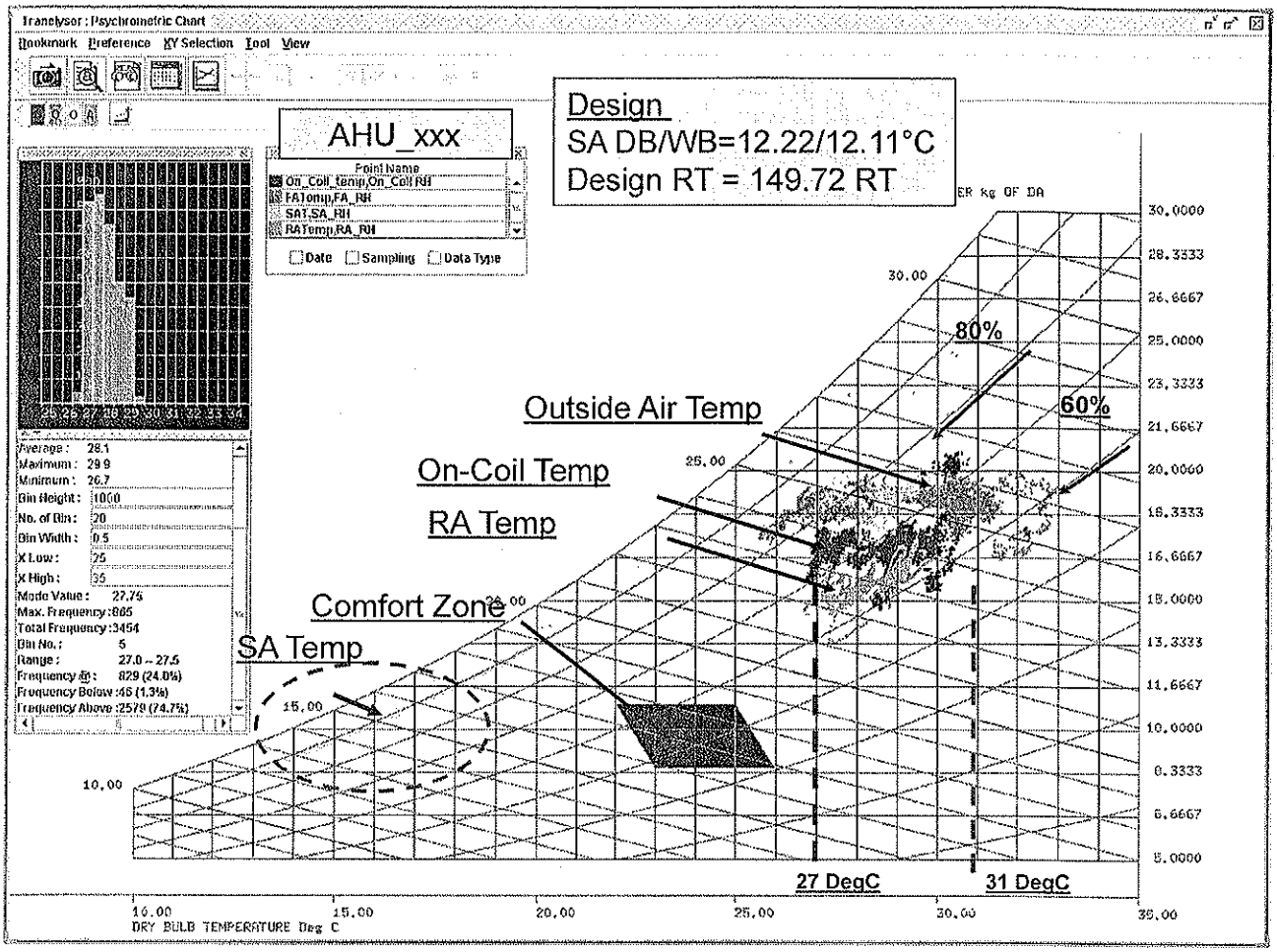
Retrofit Project Chillers



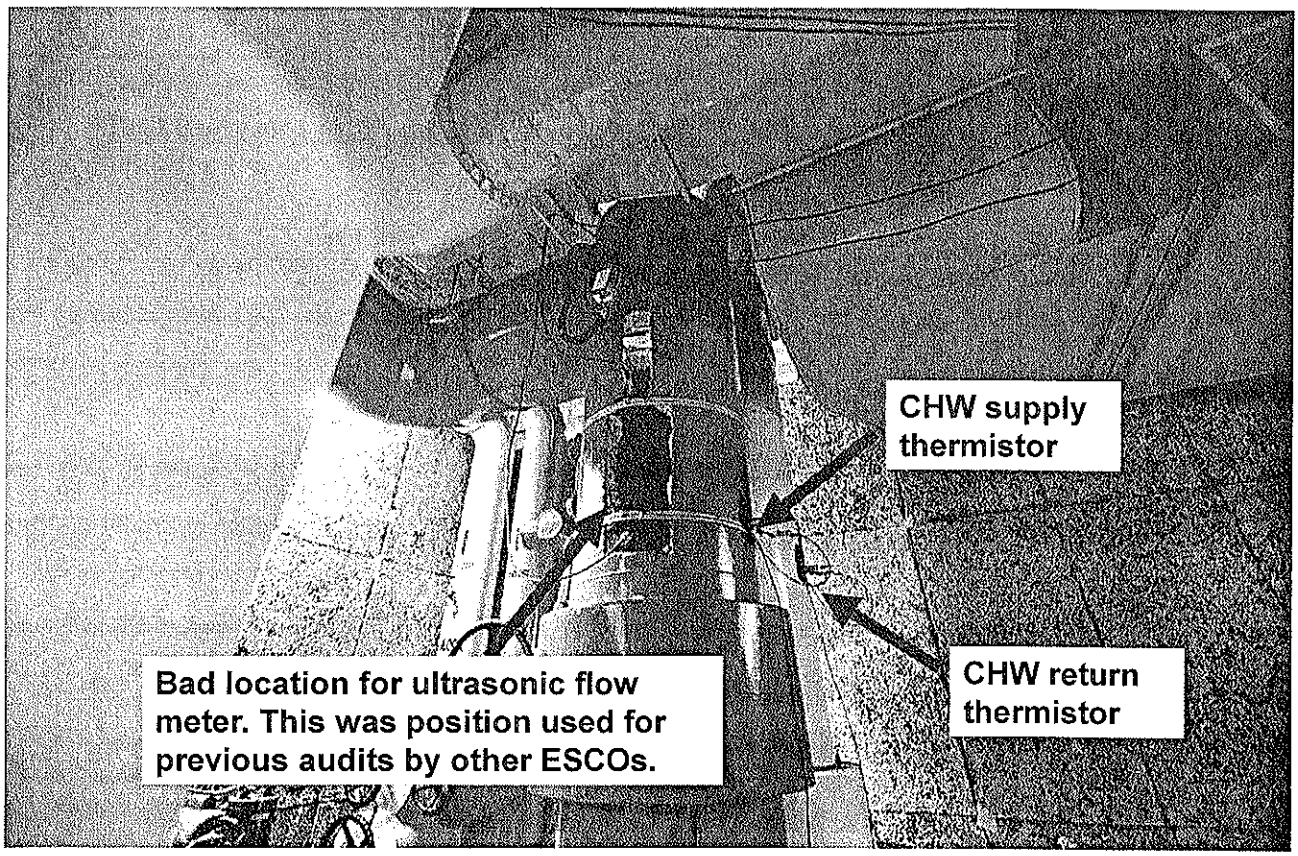
Chillers

Performance Measurement of Chiller xx

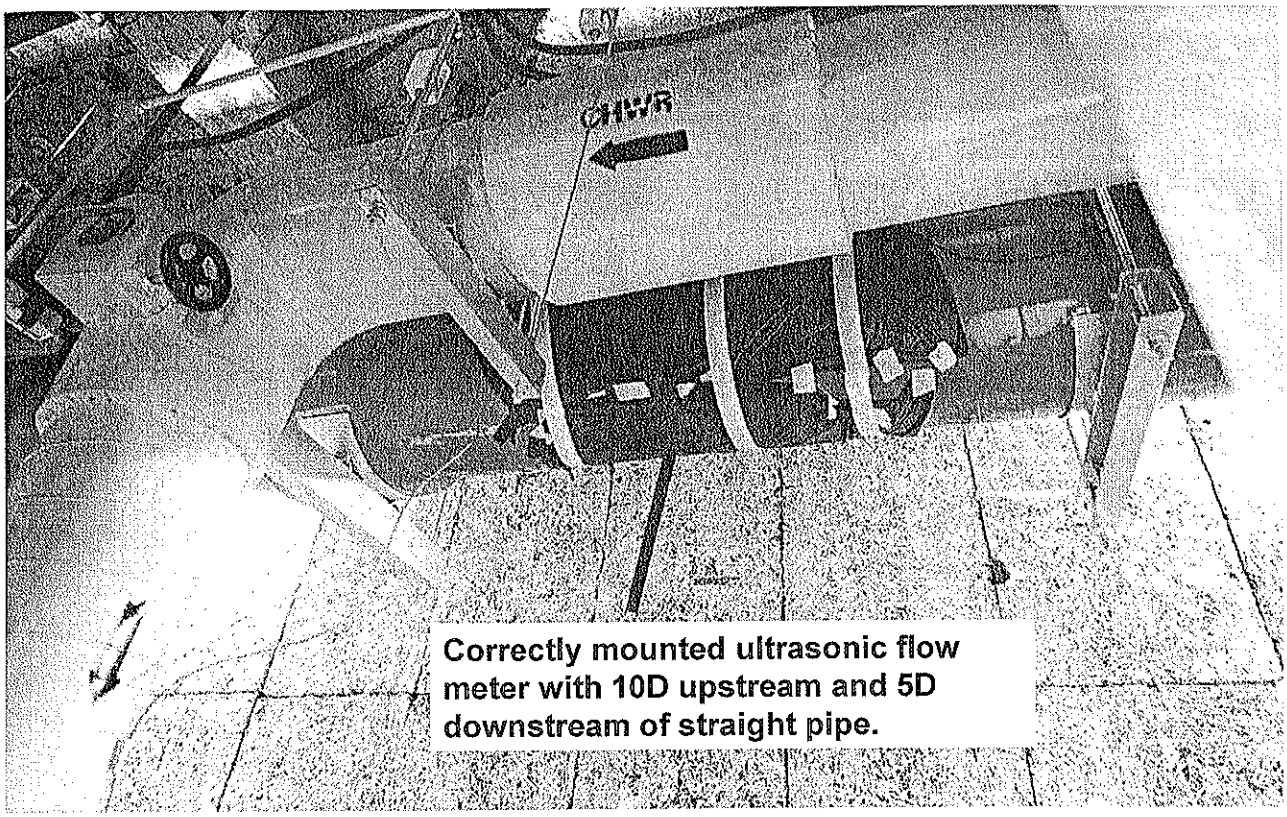




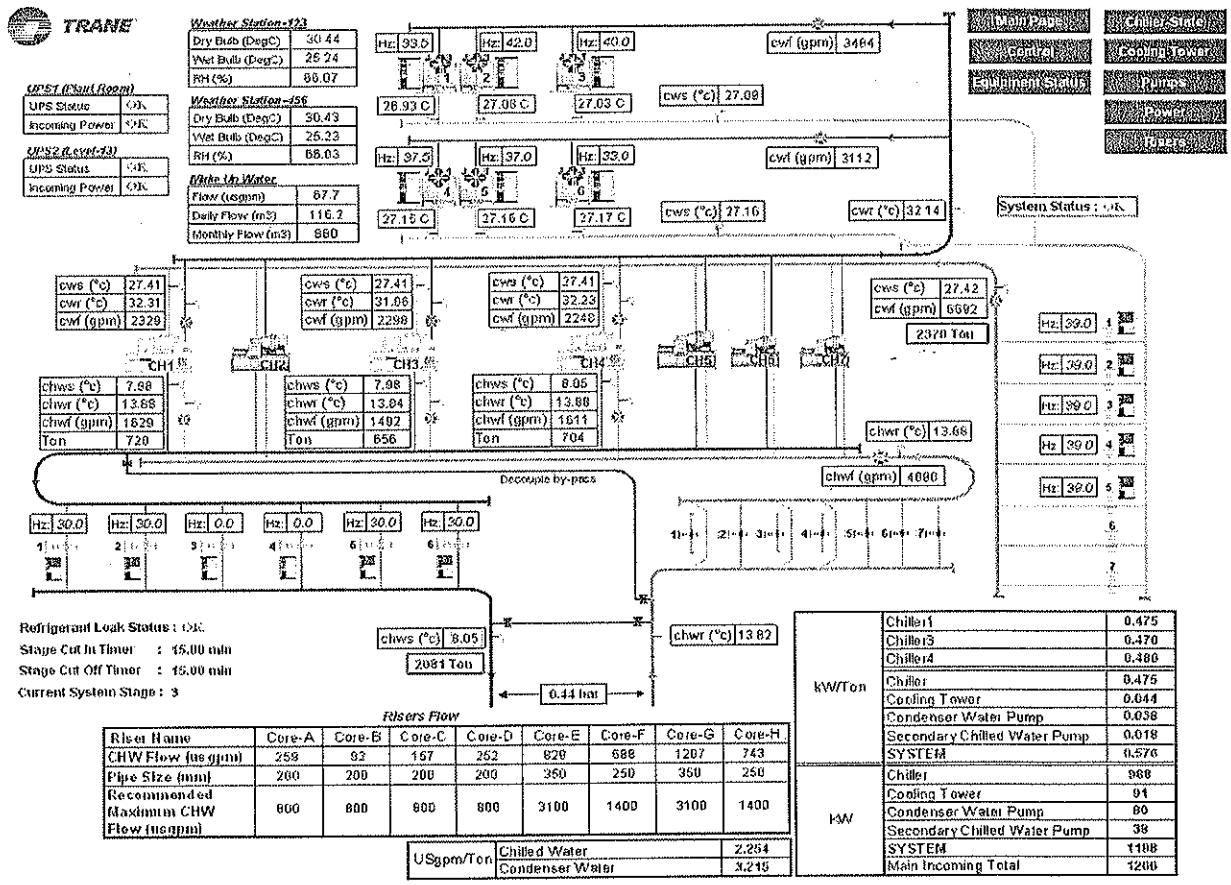
Flow measurement

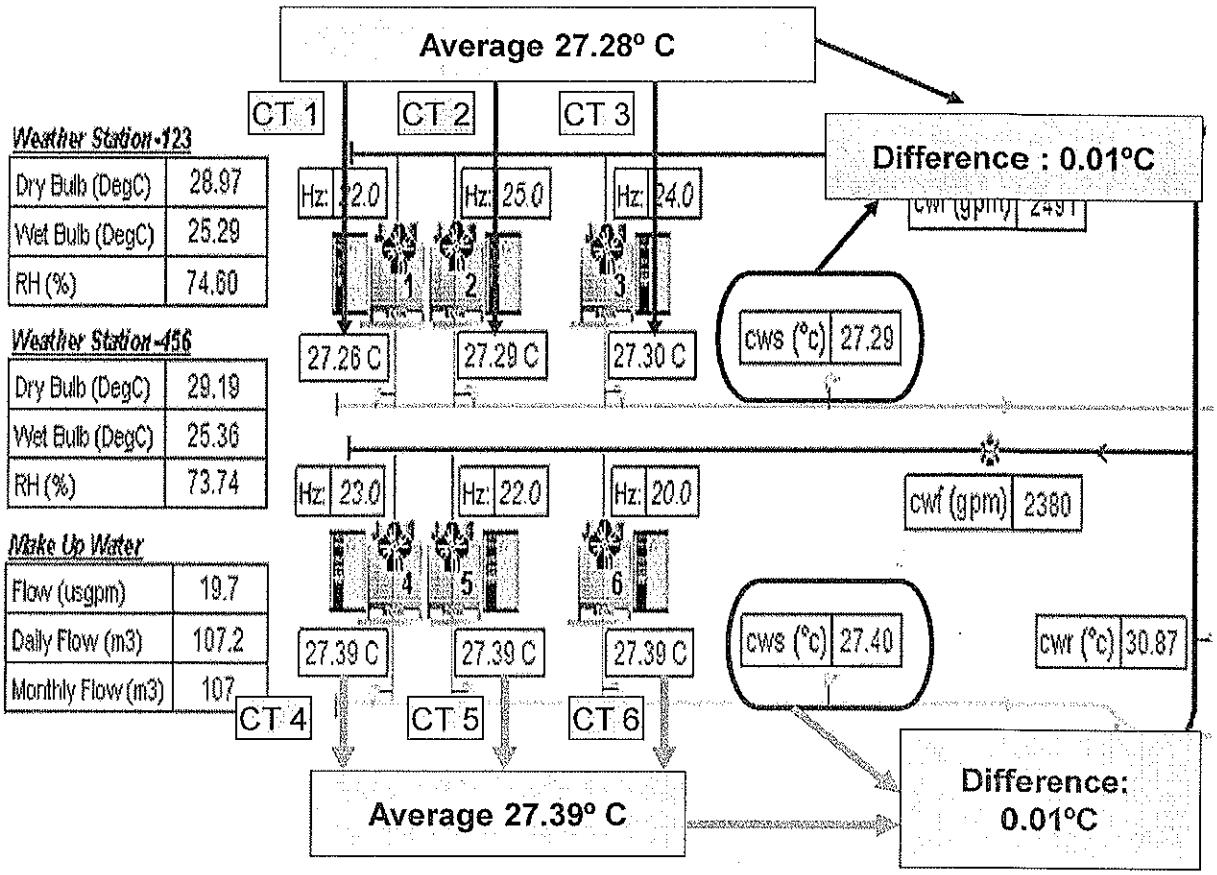


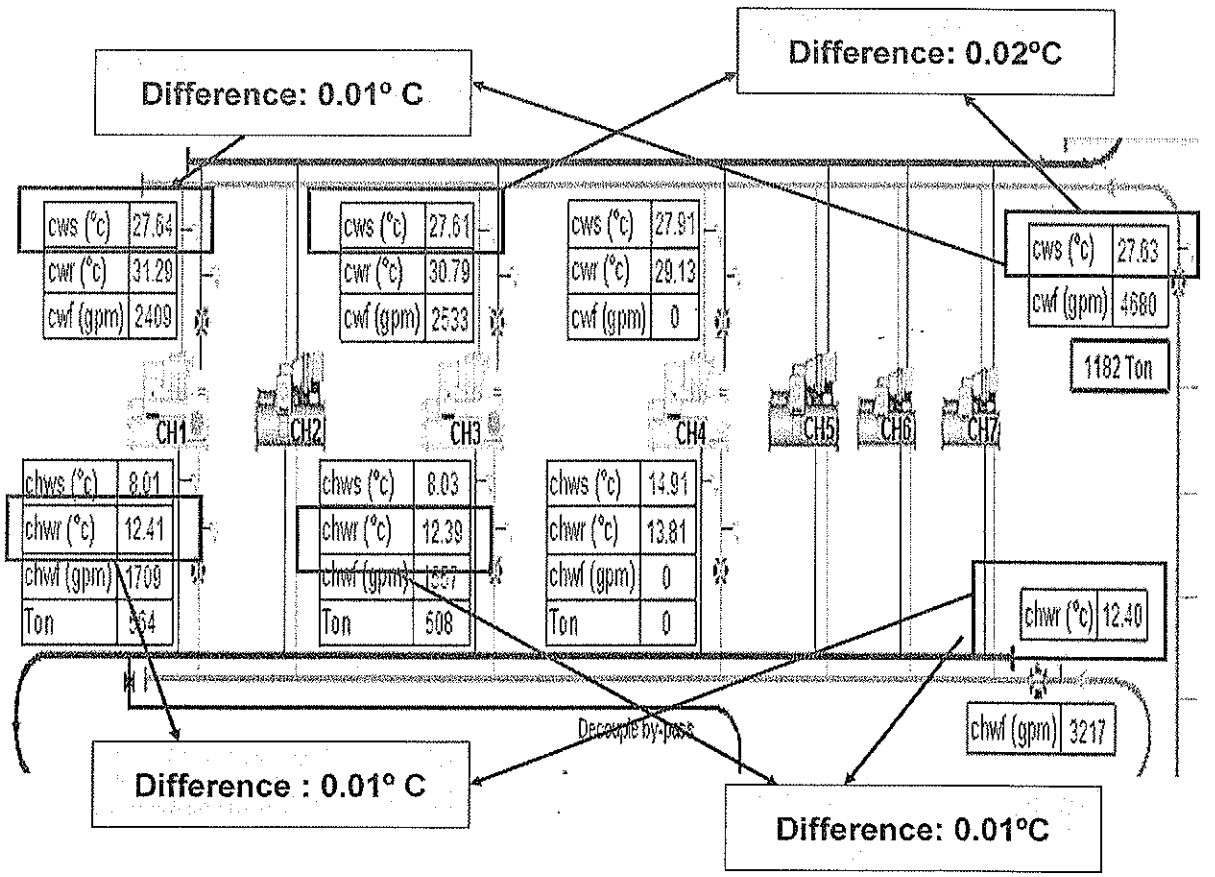
Flow measurement

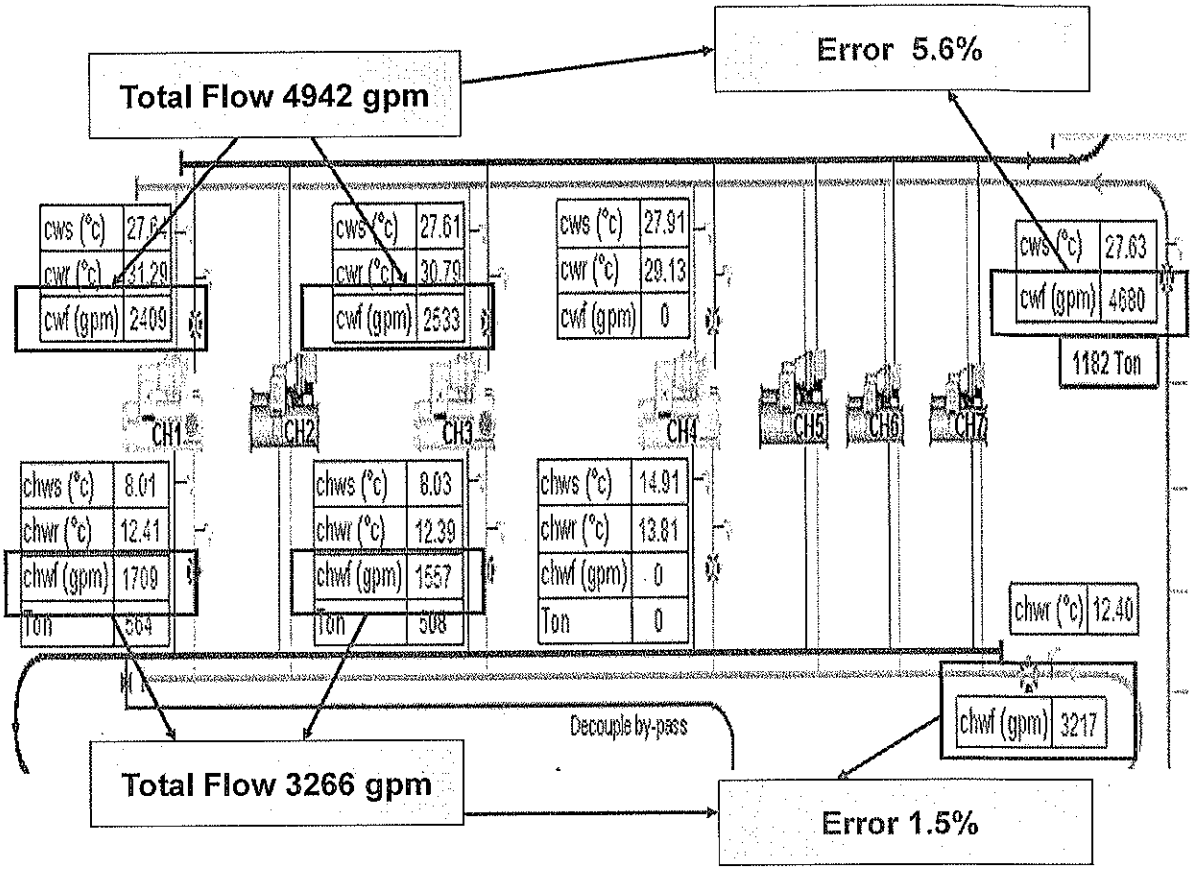


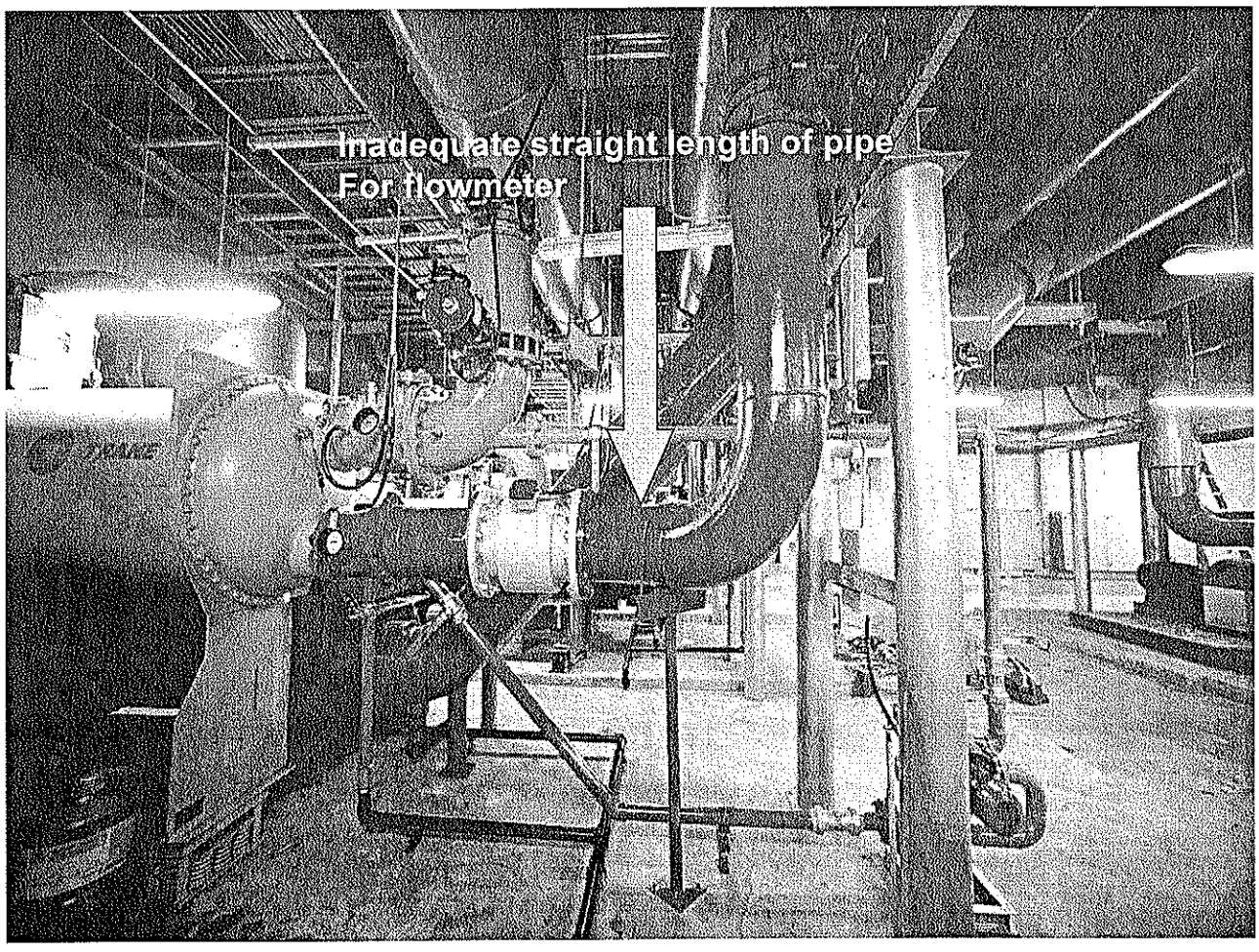
Correctly mounted ultrasonic flow meter with 10D upstream and 5D downstream of straight pipe.

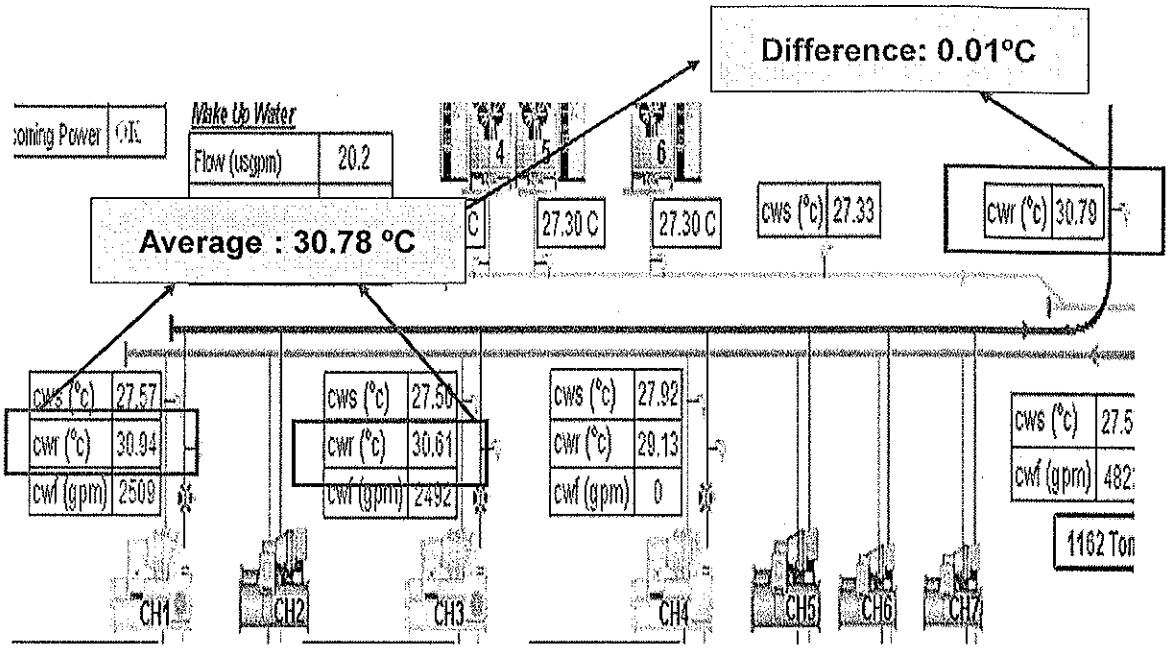



Average 27.28° C
CT 1
CT 2
CT 3
Difference : 0.01°C
Weather Station-123
Dry Bulb (DegC) 28.97
Wet Bulb (DegC) 25.29
RH (%) 74.60
Weather Station-456
Dry Bulb (DegC) 29.19
Wet Bulb (DegC) 25.36
RH (%) 73.74
Make Up Water
Flow (usgpm) 19.7
Daily Flow (m3) 107.2
Monthly Flow (m3) 107
Hz: 22.0
Hz: 25.0
Hz: 24.0
1
2
3
27.26 C
27.29 C
27.30 C
cws (°c) 27.29
cwr (gpm) 2491
Hz: 23.0
Hz: 22.0
Hz: 20.0
4
5
6
cwf (gpm) 2380
27.39 C
27.39 C
27.39 C
cws (°c) 27.40
cwr (°c) 30.87
CT 4
CT 5
CT 6
Average 27.39° C
Difference: 0.01°C

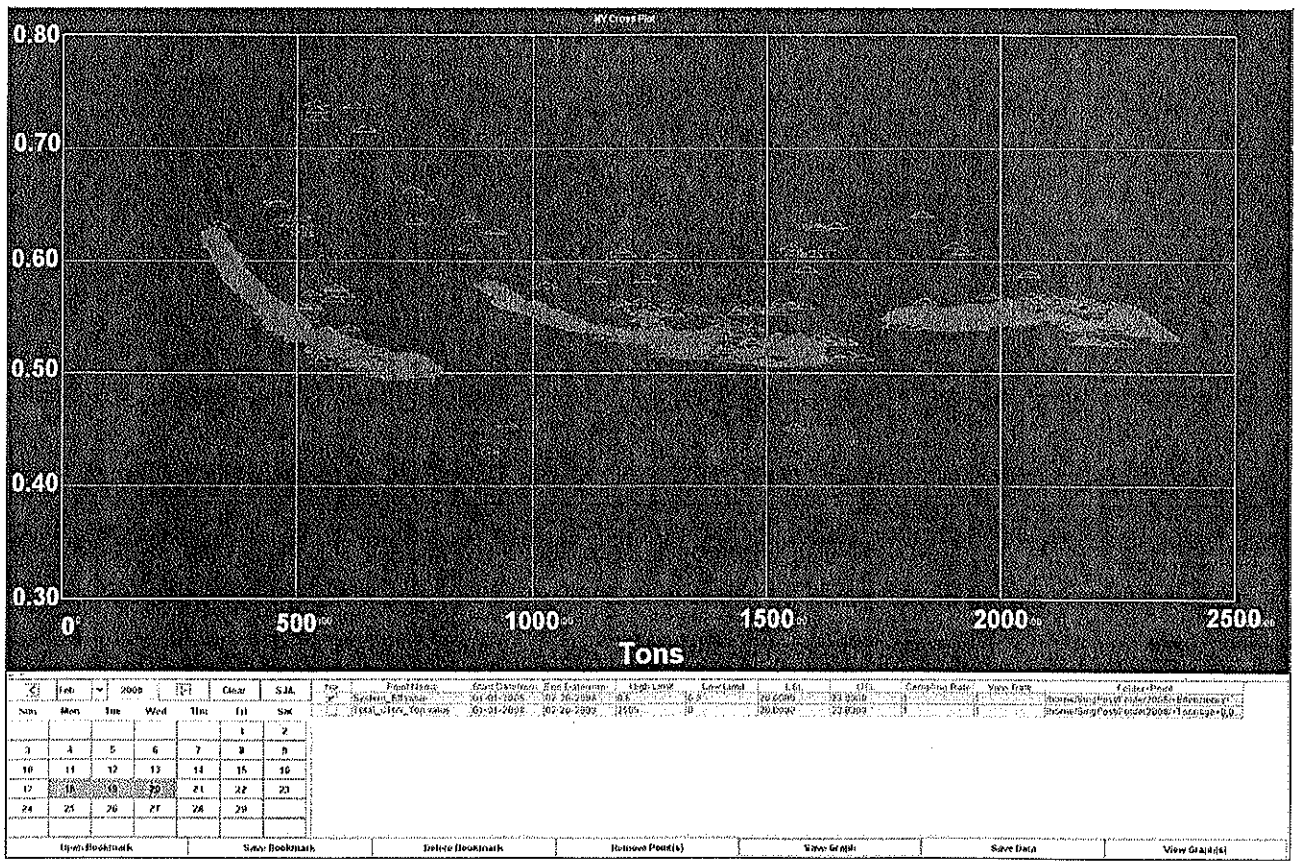

Difference: 0.01° C
Difference: 0.02°C
cws (°c) 27.64
cwr (°c) 31.29
cwf (gpm) 2409
cws (°c) 27.61
cwr (°c) 30.79
cwf (gpm) 2533
cws (°c) 27.91
cwr (°c) 29.13
cwf (gpm) 0
cws (°c) 27.63
cwf (gpm) 4680
1182 Ton
CH1
CH2
CH3
CH4
CH5
CH6
CH7
chws (°c) 8.01
chwr (°c) 12.41
chwf (gpm) 1709
Ton 364
chws (°c) 8.03
chwr (°c) 12.39
Ton 508
chws (°c) 14.91
chwr (°c) 13.81
chwf (gpm) 0
Ton 0
chwr (°c) 12.40
chwf (gpm) 3217
Decouple by-pass
Difference : 0.01° C
Difference: 0.01°C


Total Flow 4942 gpm
Error 5.6%
cws (°c) 27.61
cwr (°c) 31.20
cwf (gpm) 2409
cws (°c) 27.61
cwr (°c) 30.79
cwf (gpm) 2533
cws (°c) 27.91
cwr (°c) 29.13
cwf (gpm) 0
cws (°c) 27.63
cwf (gpm) 4680
1182 Ton
CH1
CH2
CH3
CH4
CH5
CH6
CH7
chws (°c) 8.01
chwr (°c) 12.41
chwf (gpm) 1709
Ton 864
chws (°c) 8.03
chwr (°c) 12.39
chwf (gpm) 1557
Ton 308
chws (°c) 14.91
chwr (°c) 13.81
chwf (gpm) 0
Ton 0
chwr (°c) 12.40
chwf (gpm) 3217
Decouple by-pass
Total Flow 3266 gpm
Error 1.5%

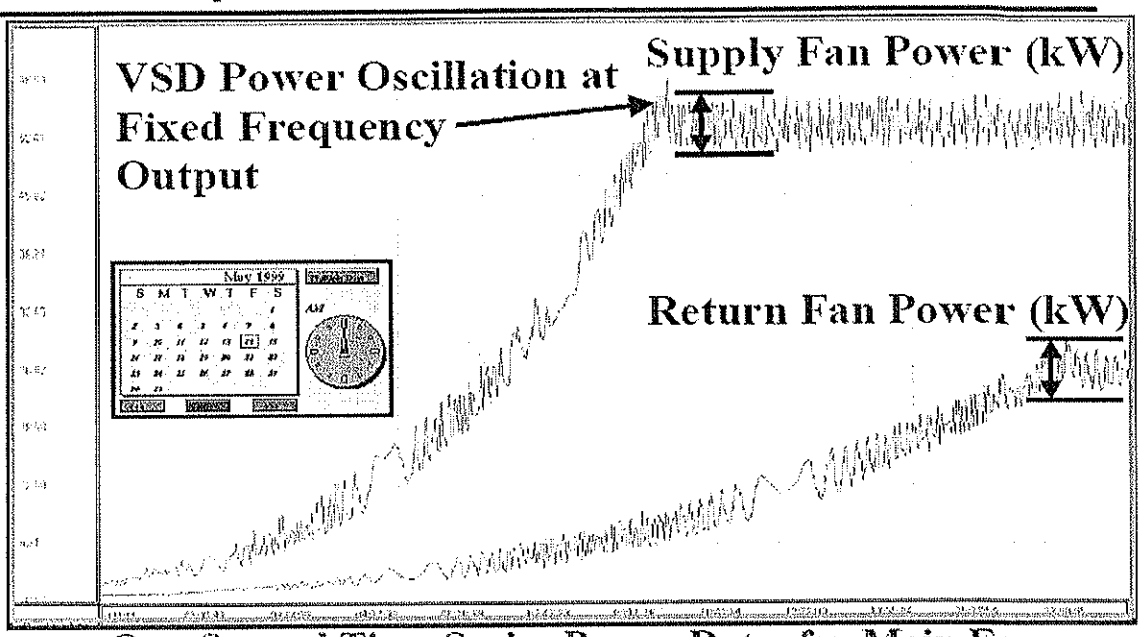

Inadequate straight length of pipe
For flowmeter



System kW/RT SingPost 18~20 Feb 2008

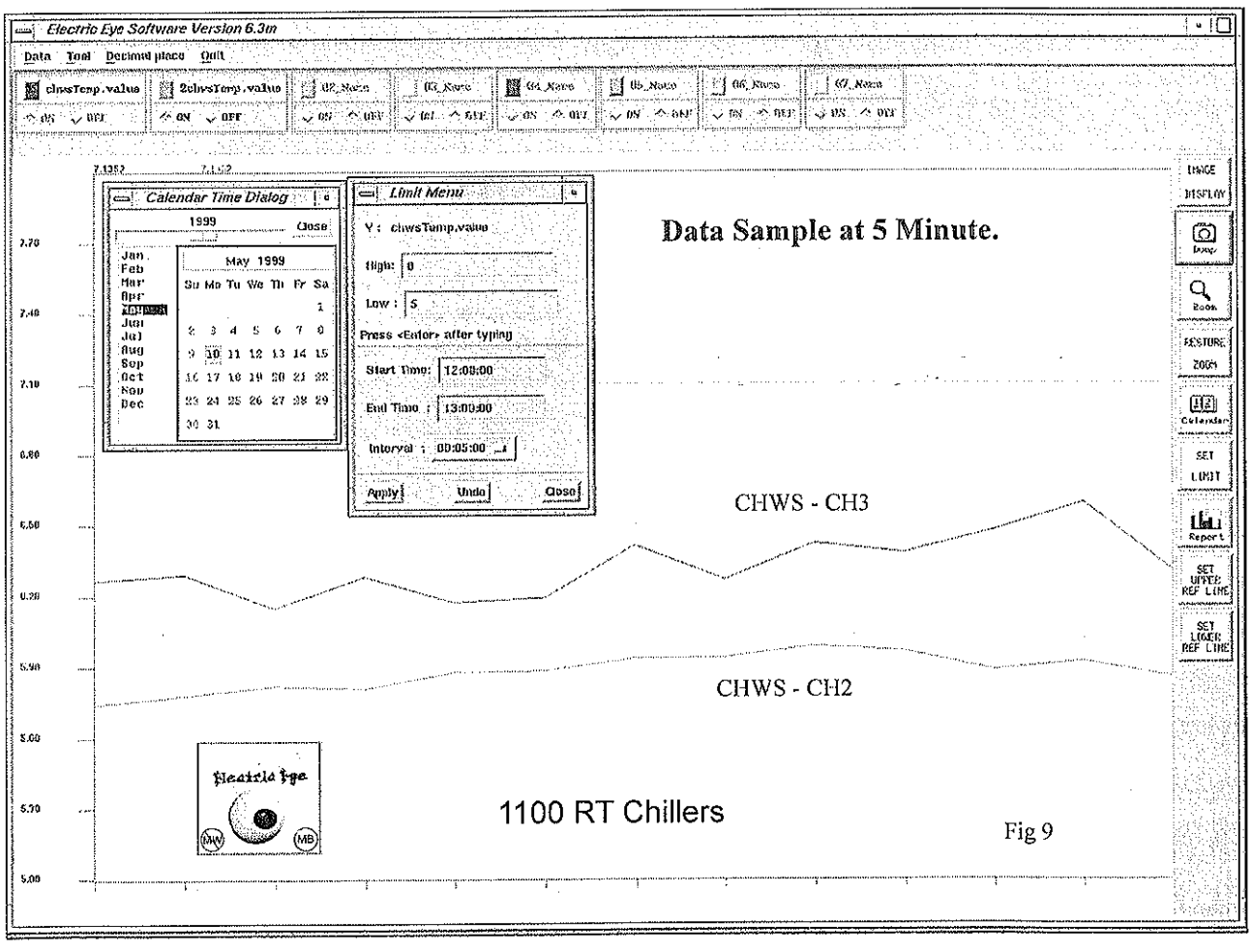


Variable Speed Drive Power (At one second)



One-Second Time Series Power Data for Main Fans

The Fan controls are not set correctly and the fans are tracking each other not operating efficiently. The fans are cycling power from loose belts. This shows what the physical condition causes.



1100 RT Chillers

Fig 9

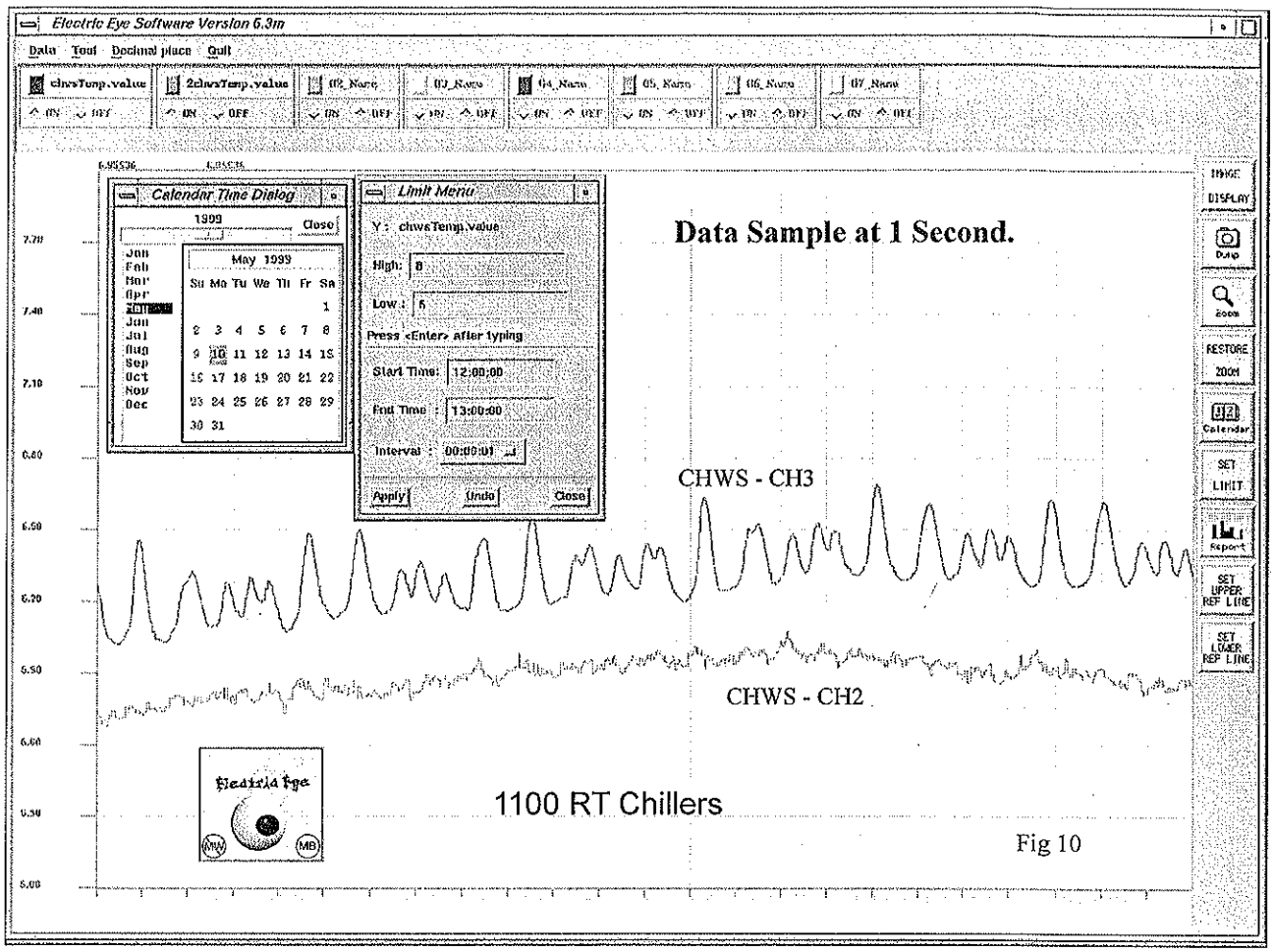
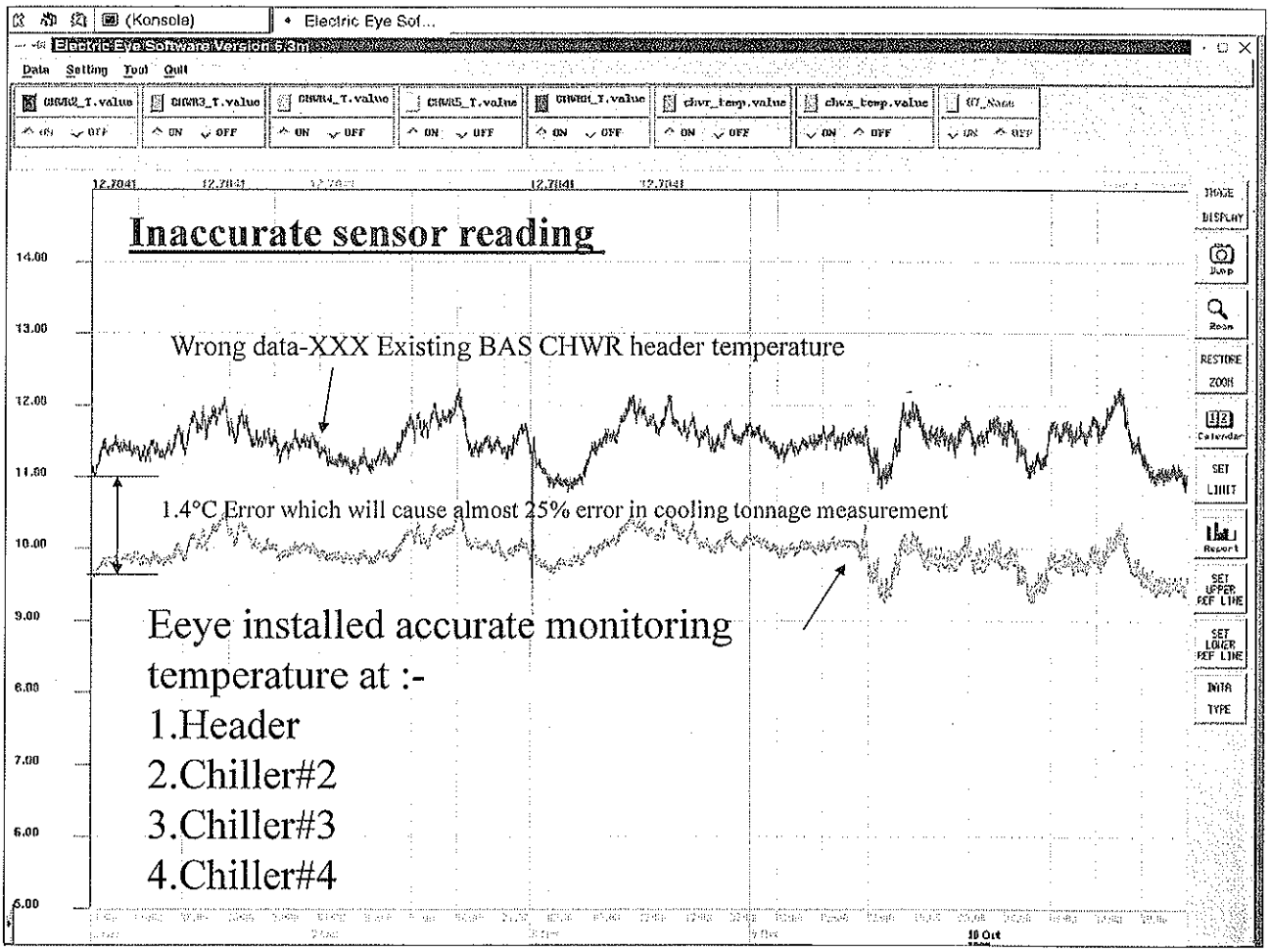
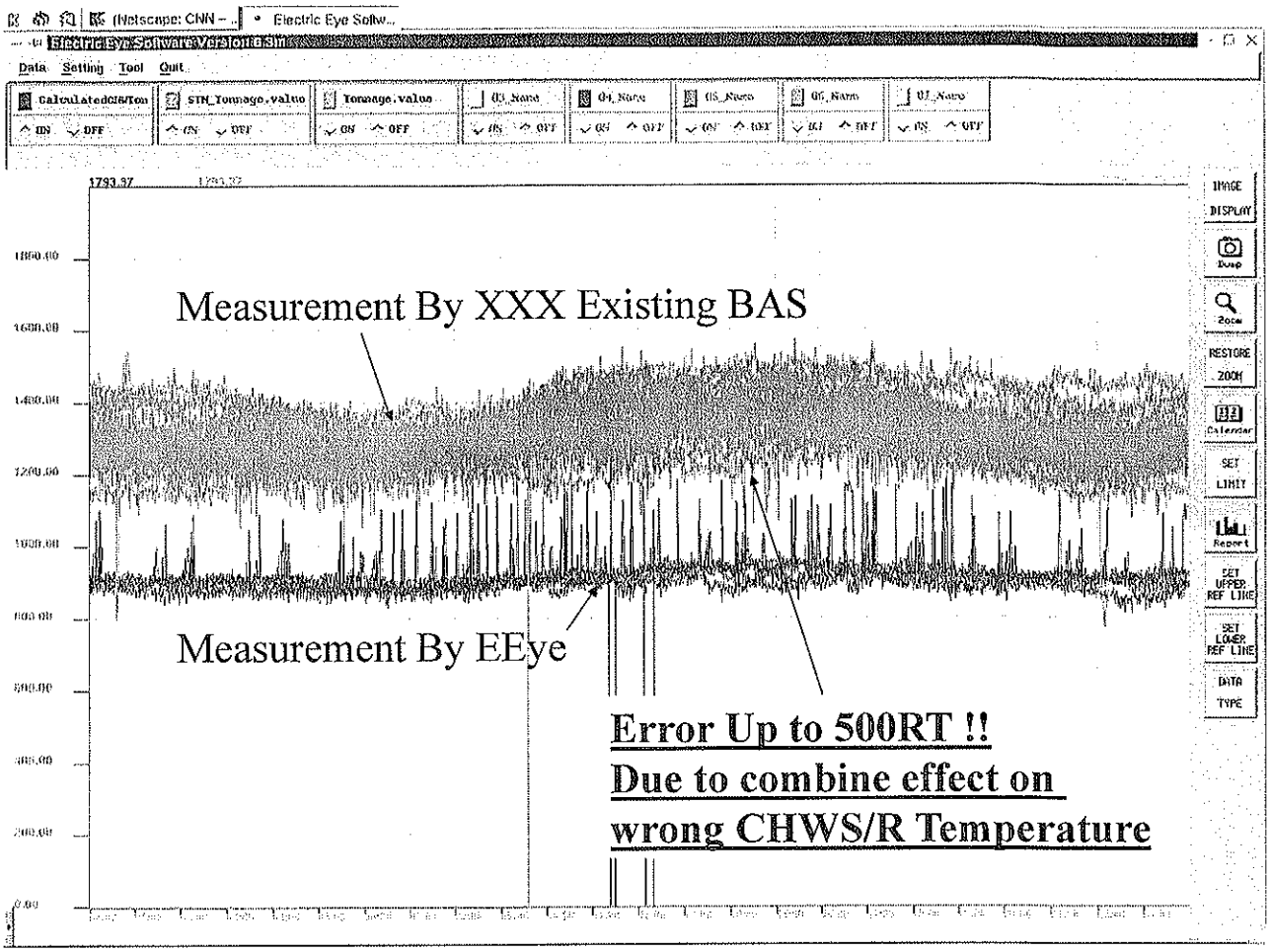
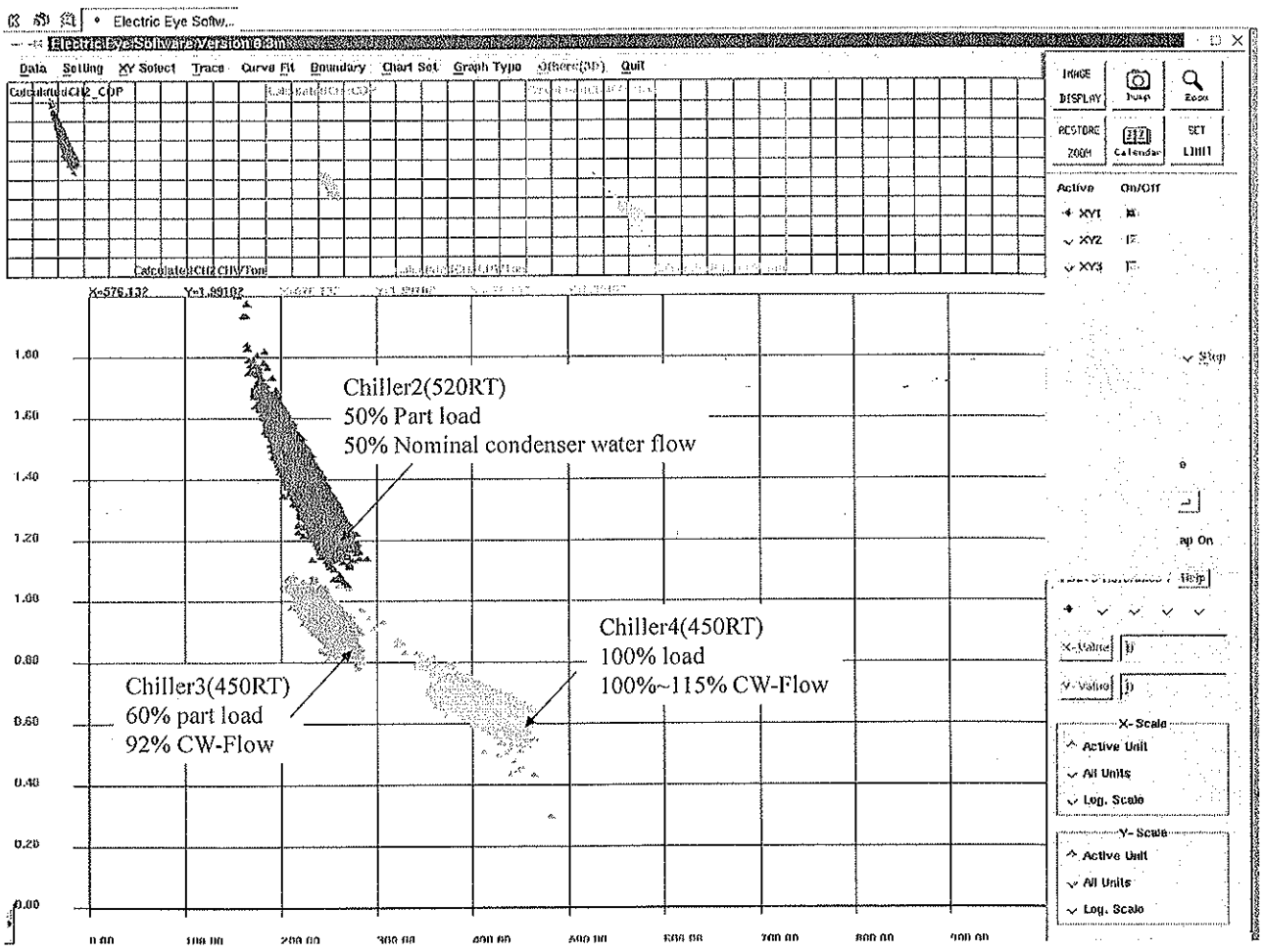

Electric Eye Software Version 6.3m
Data Tool Decimal place Quit
Calendar Time Dialog
Limit Menu
Data Sample at 1 Second.
CHWS - CH3
CHWS - CH2
1100 RT Chillers

Fig 10


Inaccurate sensor reading
Wrong data-XXX Existing BAS CHWR header temperature
1.4°C Error which will cause almost 25% error in cooling tonnage measurement
Eeye installed accurate monitoring temperature at :-
1.Header
2.Chiller#2
3.Chiller#3
4.Chiller#4


Measurement By XXX Existing BAS
Measurement By EEye
Error Up to 500RT !!
Due to combine effect on
wrong CHWS/R Temperature


Chiller2(520RT)
50% Part load
50% Nominal condenser water flow
Chiller4(450RT)
100% load
100%~115% CW-Flow
Chiller3(450RT)
60% part load
92% CW-Flow

Thank you for your attention.

Questions?