ANNEX A – Energy Audit Report For Building Cooling System

Date: DD/MM/YYYY

ENERGY AUDIT REPORT
FOR BUILDING COOLING SYSTEM

for

ENTER BUILDING NAME

at

ENTER BUILDING ADDRESS

(BUILDING IMAGE)

Submitted By

Enter name of PE/Energy Auditor

Signature of PE/Energy Auditor

PE (Mech) Registration No*: Enter No.

Energy Auditor Registration No*: Enter No.

*Delete whichever is not applicable

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1.0 Executive Summary & Recommendation

(Example)

This report highlights the findings and recommendations obtained from the energy audit performed at Enter Building Name from [Enter Period of Audit] DD/MM/YYYY to DD/MM/YYYY for 24 hrs.

Corrective measures taken by PE (Mech)/ Energy Auditor to comply with PEA Notice.

1) *<Description of findings/ measures>*
2) *<Description of findings/ measures>*
3) *<Description of findings/ measures>*

Recommended energy improvement measures for Building Owners :

1) *<Description of recommendations>*
2) *<Description of recommendations>*
3) *<Description of recommendations>*

2.0 Building Information

Enter a brief description of the building here.

Project Reference Number	: **Enter project reference indicated in CORENET submission**
Building Name	:
Building Address	:
Postal Code	:
Building Type	:
Building Age	:
Date of last Energy Audit Submission	:
Gross floor area (GFA), m^2	:
Air conditioned area, m^2	:
Number of guest rooms (for hotels/service apartments)	:

3.0 Energy Audit Information For Building Cooling System

Enter PE(Mechanical) / Energy Auditor Name was appointed by **Enter Owner Name/ MCST**, owner of **Enter Building Name** to be the Energy Auditor for the submission of the operating system efficiency (OSE) of the building cooling system. The report will present the OSE of the building cooling system based on the measurements from the permanent instrumentations installed on site.

Location	:	**Enter location of Chilled Water Plant**
Energy Audit Period	:	**Enter Energy Audit period *Note: Min 1 week**
Date of notice served	:	**Enter date of notice served by BCA**
Date of submission in notice	:	**Enter submission deadline stipulated in BCA notice**
OSE standard to comply (kW/RT)	:	**Enter Min OSE standard for Chilled Water Plant**
OSE standard to comply (kW/RT)	:	**Enter Min OSE standard for Total System Efficiency**
Data Logging Interval	:	1 minute sampling
Trend Logged Parameters*	:	Chilled Water Supply main header temperature
		Chilled Water Return main header temperature
		Chilled Water flow rate at chilled water return main header
		Condenser Water Supply main header temperature
		Condenser Water Return main header temperature
		Condenser water flow rate at condenser water return main header
		Power input to Chiller(s)
		Power input to Chilled water pump(s)
		Power input to Condenser water pump(s)
		Power input to Cooling tower(s)
		Power input to Pre-AHU(s)/AHU(s)/FCU(s)

**** Trend logged parameters are not limited to the above and may vary depending on the piping and electrical circuit design.***

I hereby confirm the following check have been carried and verified by me as part of the energy audit process.

BMS Check	
1. Temperature sensors' ABC coefficient constants input as reflected in the calibration certs	☐
Power Meter (Consistency Check)	
2. Check power meter reading and BMS reading are same	☐
3. Check power meter reading and chiller panel or pump VSD display reading is ≤ 3%	☐
4. Check the Current Transformer ratio tallies with power meter setting	☐
Flow Meter	
5. Check sum of flow meter branches tallies with flow meter header reading (if there are flowmeters at header and individual chillers)	☐
6. Check flowmeter reading and BMS reading are same	☐
7. Check flowmeter do not have any correction factor or off-set factor input	☐
Verified Temperature Sensor Accuracy	
8. Use calibrated reference temperature sensor with end-to-end uncertainty of ≤0.05 ^{o}C	☐
9. Synchronise the reference temperature sensor device timing with BMS	☐
10. Collect at least 20 sets of reading from reference temperature sensor device (after insertion into spare test plug) and BMS	☐
11. Compare the difference between both set of readings, with average of absolute difference to be ≤ 0.07 ^{o}C	☐

3.1 Chilled Water Plant Design Information*

ID	Description	Brand	Type	Name plate motor (kW)	Total Cooling Capacity (RT)	Chilled water LWT/EWT	Rated Efficiency kW/RT	Year Installed
CH01	Chiller 1	Brand X	Centrifugal, water-cooled	162.8	300	7.5 °C	0.543	2017
CH02	Chiller 2	Brand X	Centrifugal, water-cooled	162.8	300	7.5 °C	0.543	2017
CH02	Chiller3	Brand X	Centrifugal, water-cooled	162.8	300	7.5 °C	0.543	2017

Table 1: Chiller Information (Example)

ID	Brand	Type	Name plate motor (kW)	Pump Head (m)	Flow rate (L/S)	Rated Pump/ Fan efficiency	Rated Motor Efficiency
CHWP 1	Brand X	end suction	11	23	33.65	80.0%	92.4%
CHWP 2	Brand X	end suction	11	23	33.65	80.0%	92.4%
CHWP 3	Brand X	end suction	11	23	33.65	80.0%	92.4%
CWP 1	Brand Y	end suction	15.0	16.0	56.82	79.0%	92.4%
CWP 2	Brand Y	end suction	15.0	16.0	56.82	79.0%	92.4%
CWP 3	Brand Y	end suction	15.0	16.0	56.82	79.0%	92.4%
CT 1	Brand Z	cross flow	5.5 x 1 Cell	-	66.2	75%	86%
CT 2	Brand Z	cross flow	5.5 x 1 Cell	-	66.2	75%	86%
CT 3	Brand Z	cross flow	5.5 x 1 Cell	-	66.2	75%	86%

Table 2: Ancillary water-side equipment Information (Example)

*Based on equipment design specifications and name plate ratings

3.2 Air-Side Design information*

ID	Model (Serial Number)	Type (Centrifugal/ EC Centrifugal / Axial)	Motor Power (kW)	Input Power (kW)	Rated Airflow (m^3/h)	Ext Static Pressure (Pa)	Total Static Pressure (Pa)	Cooling Capacity (Ton)	Filter Type/ Rating	Outdoor air provision
AHU 1	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	Direct opening to external/ via PAHU or FAF
AHU 2	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	
AHU 3	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	
AHU 4	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	
AHU 5	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	
AHU 6	Mod Xx	Centrifugal	3.0	2.67	6523	205	768	10.2	Bag/F7	
Pre-Cooled AHU 1	Mod Yx	Centrifugal	11.0	10.8	18500	705	1221	42	Bag/F7	
Pre-Cooled AHU 2	Mod Yx	Centrifugal	11.0	10.8	18500	705	1221	42	Bag/F7	
Summation			-	X	-	-	-	X	-	

Table 3: Ancillary air-side equipment Information (Example)

*Based on equipment design specifications and name plate ratings

3.3 Chilled Water Plant Normal Operating Hours

Monday to Friday : 1000 – 2100 Hrs

Saturday / Sunday : No operations

Note: The audit period shall be based on the operating hours defined in the subsection 4.1.1 of the Energy Audit Code.

3.4 Description of Plant Control Strategy

Summary of the present plant control strategy adopted for the applicant's building chiller plant systems' operation. You may include but not limited to the following:

1) Chiller sequencing

Describe how the chiller(s) operate to handle the varying building cooling load e.g. chiller cut-in/out sequence varying with building load and addressing peak and off peak load based on (supply water temperature, and/or building load, and/or compressor current running load amps) and time delay.

2) Chilled water pump (if applicable)

Describe the parameters used to control chilled water pumps
e.g. pump speed modulate based on ((differential) pressure sensor located at chiller header, or remote AHU cooling coil, or several zones of AHU cooling coil, or optimising pump pressure by critical valve control), set-point(s) and bypass valve controls to ensure chillers operate at minimum flow rate

3) Condenser water pump (if applicable)

Describe the parameters used to control condenser water pumps
e.g. modulate to maintain condenser water differential temperature set point or gpm/ton and the set-point(s).

4) Cooling tower (if applicable)

Describe the parameters used to control cooling towers
e.g. Modulate base on cooling tower approach temperature (difference between CT leaving water temperature and ambient wet-bulb temperature) set point (adjustable), or scheduled cooling tower leaving temperature set point, or dynamic optimized cooling tower leaving water temperature set point and the set-point(s)

5) Other optimisation (if applicable)

Describe any other optimisation used
e.g. Chilled water supply temperature reset. At off-peak period, reset based on outdoor air temperature/humidity, or VPF bypass control, or predefined schedule.
(Note: Resetting CHW temperature may incur higher pump power and may compromise on space temperature and relative humidity)

Example of the information to be provided on the control strategy adopted is as illustrated below :

System adopted : Variable Primary Chilled Water System

Chiller Configuration:<*x*> **unit(s) of** <*x*> **RT chiller &** <*x*> **unit(s) of** <*x*> **RT chiller**

Variable Condenser Pump

1) Chiller sequencing

Scenario for Cut-in: *Chilled water supply header temperature is above set point of <x> °C + <deadband> OR total system tonnage is above <x> RT for a period of <x> minutes.*

Scenario for Cut-out: *Chilled water supply header temperature is below set point of <x> °C + <deadband> AND total system tonnage is below <x> RT for a period of <x> minutes.*

Time delay: *Whenever any chiller cuts-in/out, there is <x> minutes delay to allow system to stabilize.*

2) Chilled water pump (CHWP)

Primary CHWP speed is modulated to maintain a differential pressure set point of <x> psi + <deadband>. Differential pressure sensors are installed at chilled water pipe headers. CHWP speed is limited to <x> Hz to ensure chillers running at minimum flow. When CHWP speed ramps down to minimum and differential pressure rises above set point, the bypass valve will open to maintain DP set point and minimum flow rate.

3) Condenser water pump (CWP) <fixed/variable>

Minimum running speed of CWP is <x> Hz. When condenser flow rate is reduced to set point of <x> l/s or <x> gpm/ton, CWP speed would be increased and vice versa.

4) Cooling Tower (CT)

CT fan speed is modulated to maintain leaving condenser water temperature set point of <x> °C which is equal to outdoor air wet-bulb temp plus <x> °C. When chiller(s) is in operation, all CTs would be turn on. When CT leaving water temperature falls below the set point, CT fan speed would be decreased until minimum speed of <x> Hz.

5) Other Optimisation

Chilled water temperature set point is reset to <x> °C during off-peak period from 2000hrs to 0800hrs.

4.0 Instrumentations

Accurate measuring instruments complying with the Code on Environmental Sustainability Measures for Existing Buildings or the Code for Environmental Sustainability of Buildings (2nd edition and onwards) that is prevailing at the time of installation were used during the audit to gather information on the power consumption, temperatures and flow rate.

The points of measurements are listed in the following table:

ID / Serial No.	Brand	Sensor Type	Installation Location	Measurement Uncertainty (%)	Last Calibration Date	Calibration Laboratory
EP80367	Brand X	10K Ω Thermistor	CHWS Header	±0.03 °C	09/05/2014	XX laboratory
EP80364	Brand X	10K Ω Thermistor	CHWR Header	±0.03 °C	09/05/2014	XX laboratory
EP80361	Brand X	10K Ω Thermistor	CWS Header	±0.03 °C	09/05/2014	XX laboratory
EP80363	Brand X	10K Ω Thermistor	CWR Header	±0.03 °C	09/05/2014	XX laboratory
3k67201343004	Brand X	Magnetic Full Bore	CHWR Header	0.5%	29/10/2013	factory calibration
3k67201418063	Brand X	Magnetic Full Bore	CWR Header	0.5%	09/05/2014	factory calibration
38498	Brand X	True RMS, 3 phase	MSB Incoming 1	0.5%	08/07/2014	factory calibration
1402404	Brand X	True RMS, 3 phase	MSB Incoming 2	0.5%	08/07/2014	factory calibration
38491	Brand X	True RMS, 3 phase	CH/6-1	0.5%	08/07/2014	factory calibration
38487	Brand X	True RMS, 3 phase	CHP/6-1	0.5%	08/07/2014	factory calibration
38490	Brand X	True RMS, 3 phase	CWP/6-1	0.5%	08/07/2014	factory calibration
38499	Brand X	True RMS, 3 phase	CT/6-1	0.5%	08/07/2014	factory calibration
38497	Brand X	True RMS, 3 phase	CH/6-2	0.5%	08/07/2014	factory calibration
38483	Brand X	True RMS, 3 phase	CHP/6-2	0.5%	08/07/2014	factory calibration
1402325	Brand X	True RMS, 3 phase	CWP/6-2	0.5%	08/07/2014	factory calibration
38572	Brand X	True RMS, 3 phase	CT/6-2	0.5%	08/07/2014	factory calibration
1402399	Brand X	True RMS, 3 phase	CH/6-3	0.5%	08/07/2014	factory calibration
38574	Brand X	True RMS, 3 phase	CHP/6-3	0.5%	08/07/2014	factory calibration
38485	Brand X	True RMS, 3 phase	CWP/6-3	0.5%	08/07/2014	factory calibration
38486	Brand X	True RMS, 3 phase	CT/6-3	0.5%	08/07/2014	factory calibration

Table 4: Instrumentation Table (Example)

5.0 Chiller Plant Performance Analysis (1 week data)

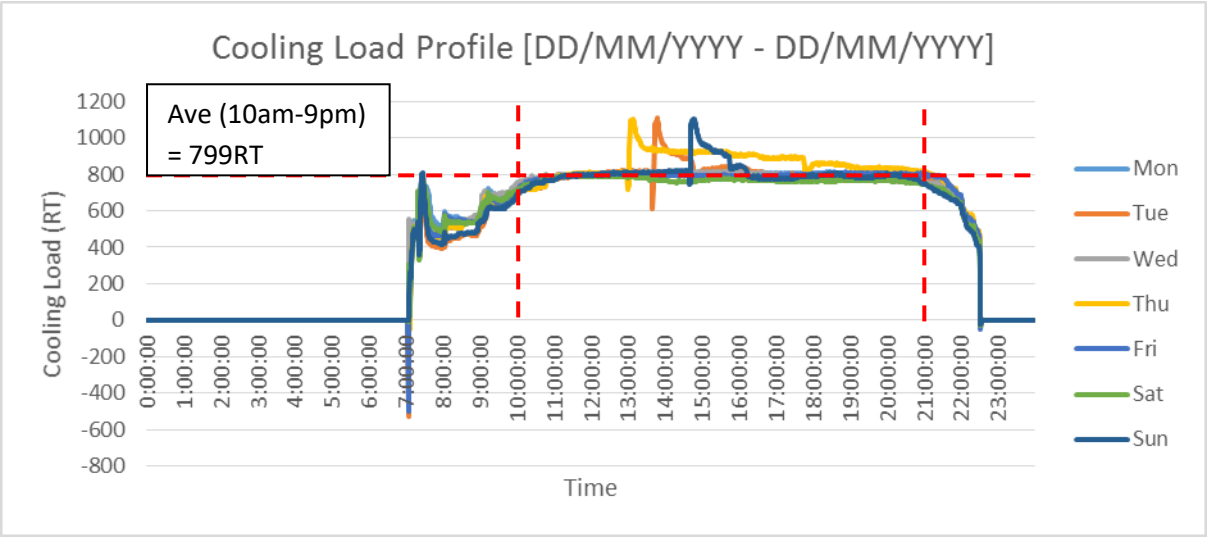

Figure 1: Super-imposed plot of 24 hr Cooling Load Profile RT (Example)

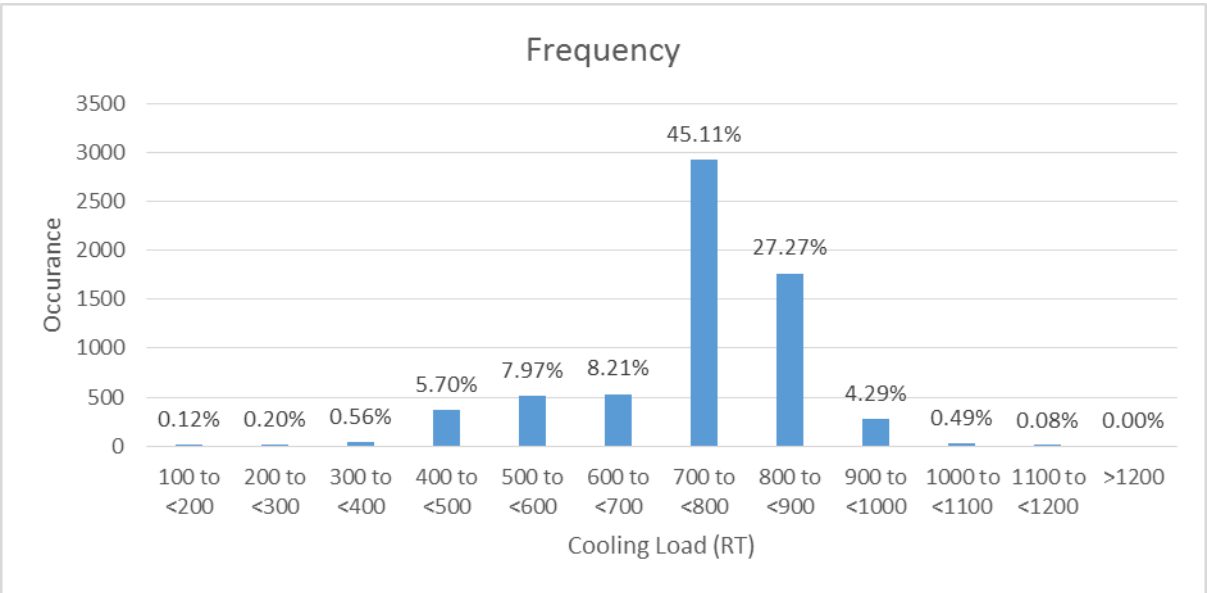

Figure 2: Histogram of Cooling Load Occurrences (Example)

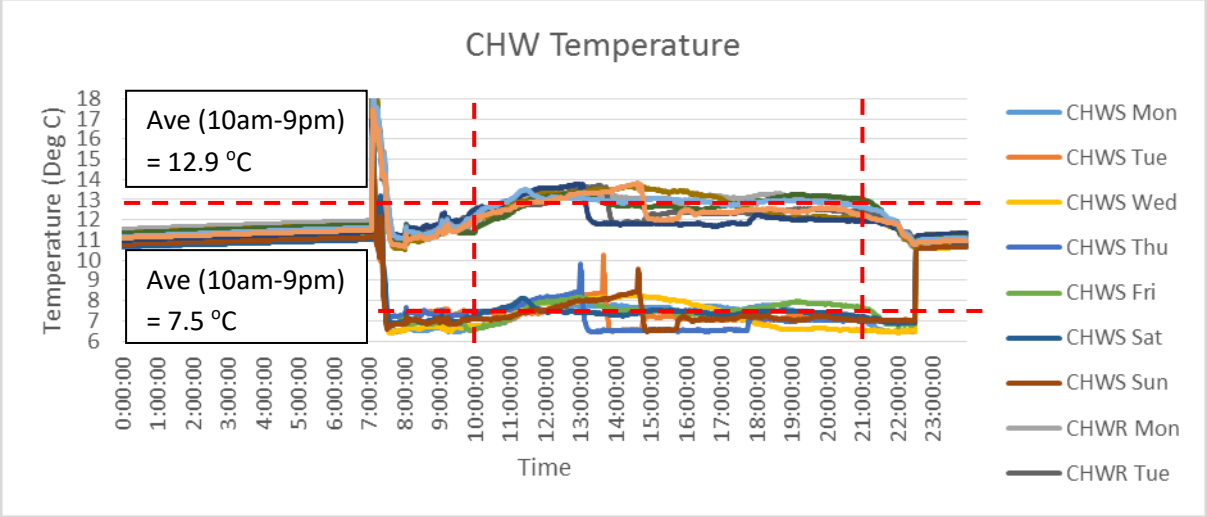

Figure 3: Super-imposed plot of daily chilled water supply/return temperature °C (Example)

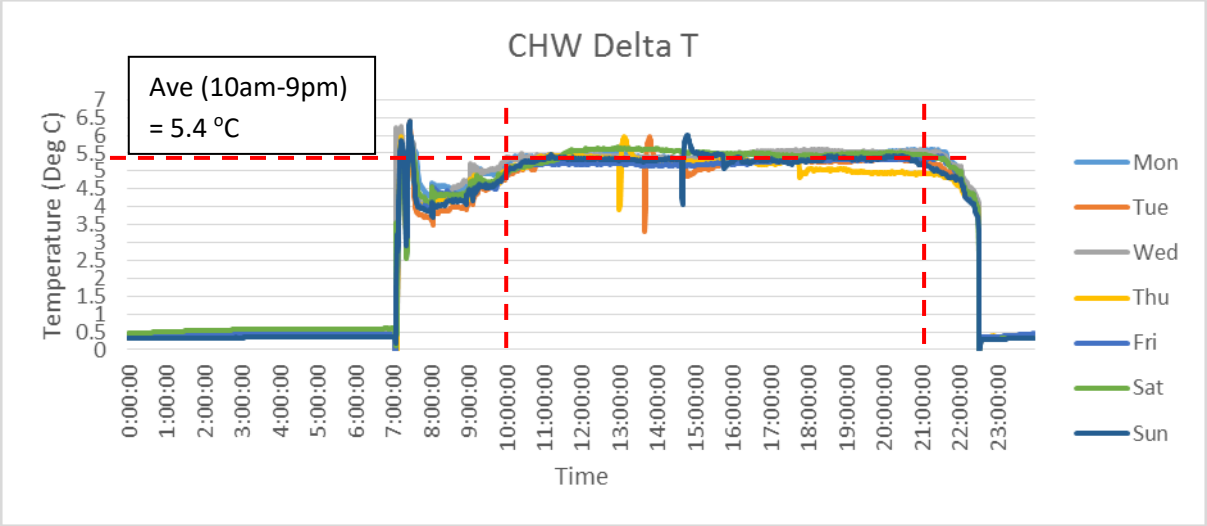

Figure 4: Super-imposed plot of daily chilled water temperature difference °C (Example)

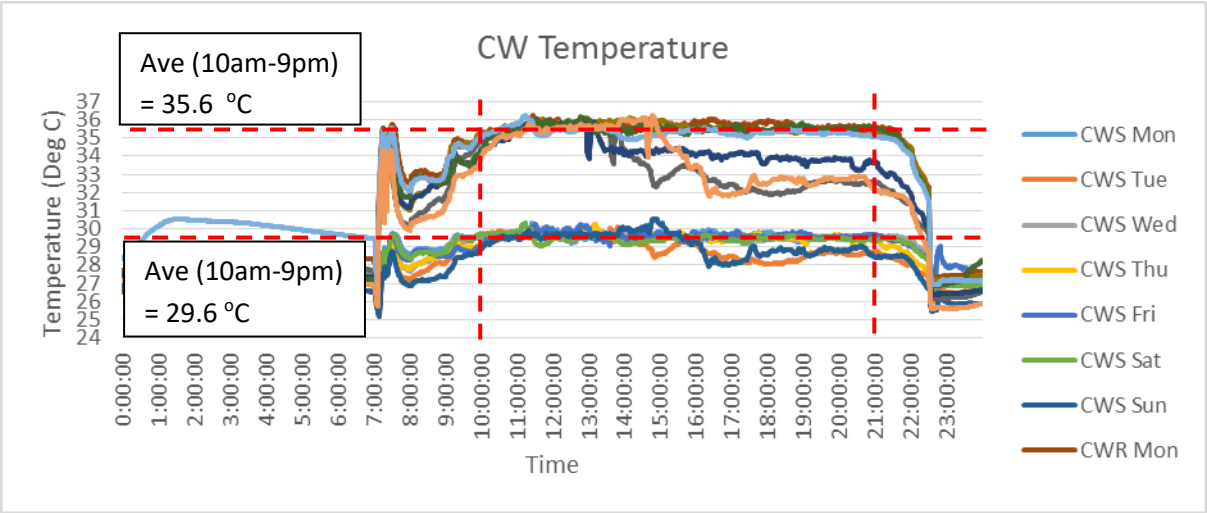

Figure 5: Super-imposed plot of daily condenser water supply/return temperature °C (Example)

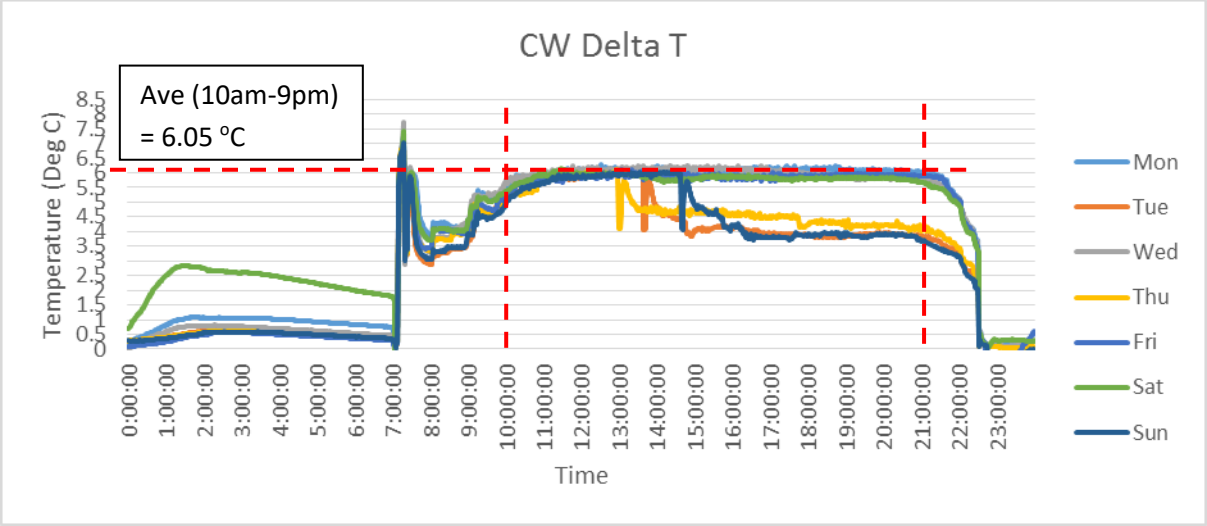

Figure 6: Super-imposed plot of daily condenser water temperature difference °C (Example)

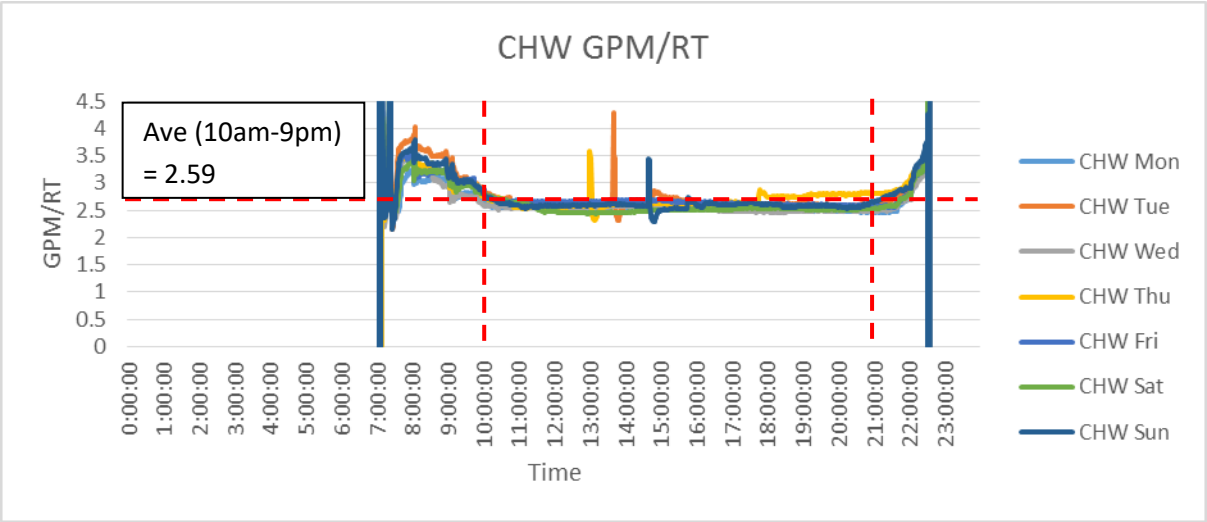

Figure 7: Super-imposed plot of daily chilled water GPM/RT (Example)

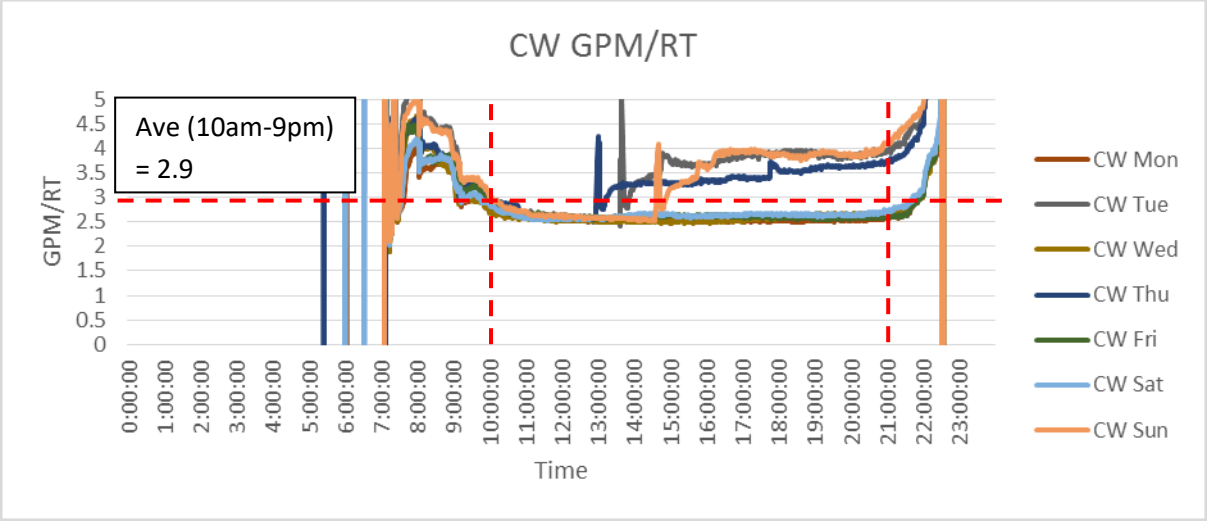

Figure 8: Super-imposed plot of daily condenser water GPM/RT (Example)

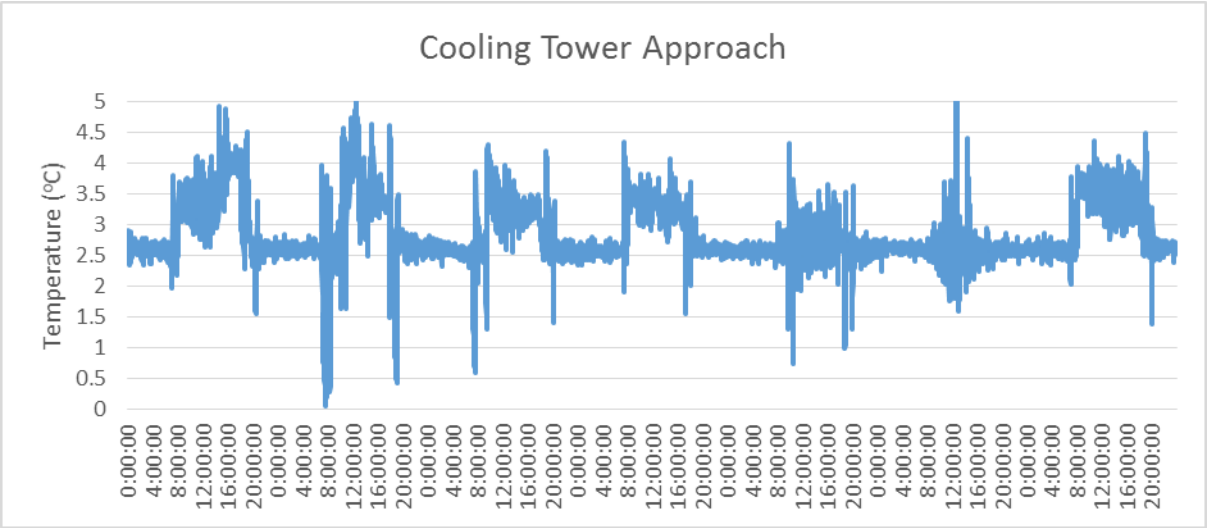

***Figure 9: Cooling Tower Approach Temperature (Example)**

*required if using wet bulb temperature as set point

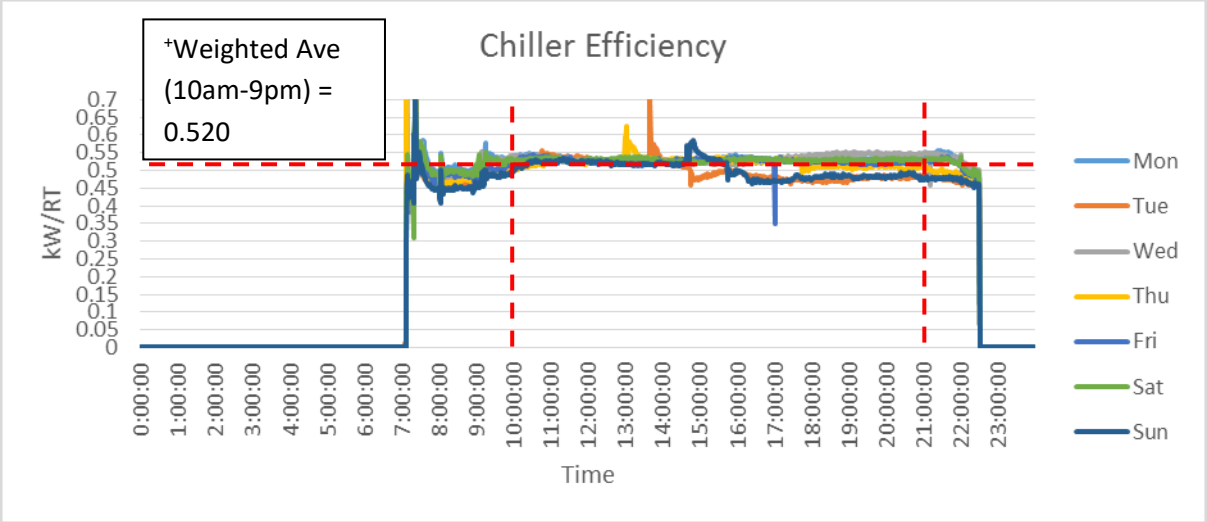

Figure 10: Super-imposed plot of daily chiller efficiency kW/RT (Example)

+Weighted average: ∑ kW-hr / ∑ RT-hr

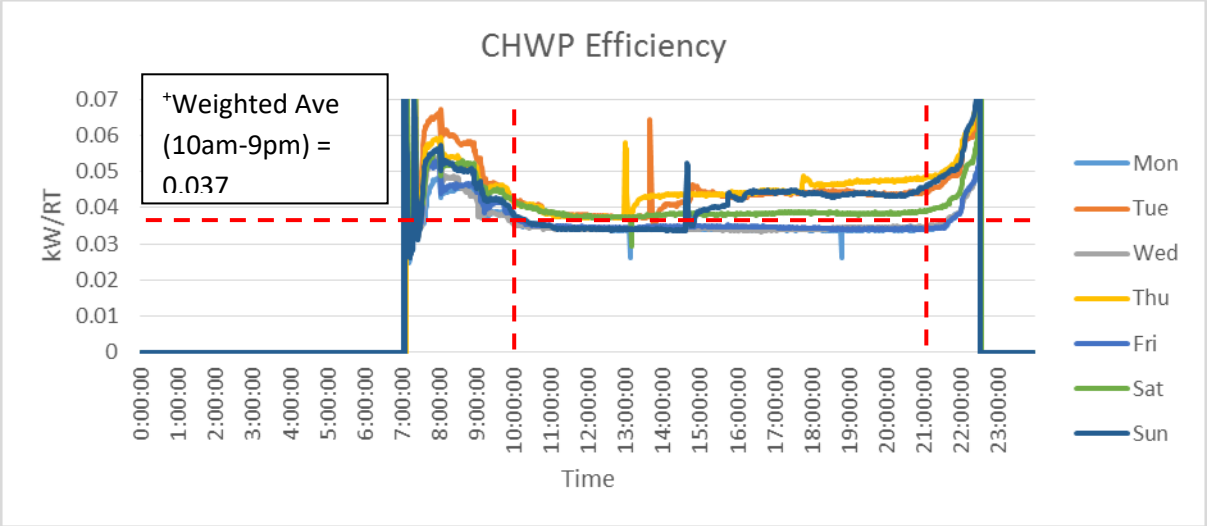

Figure 11: Super-imposed plot of daily chilled water pump efficiency kW/RT (Example)

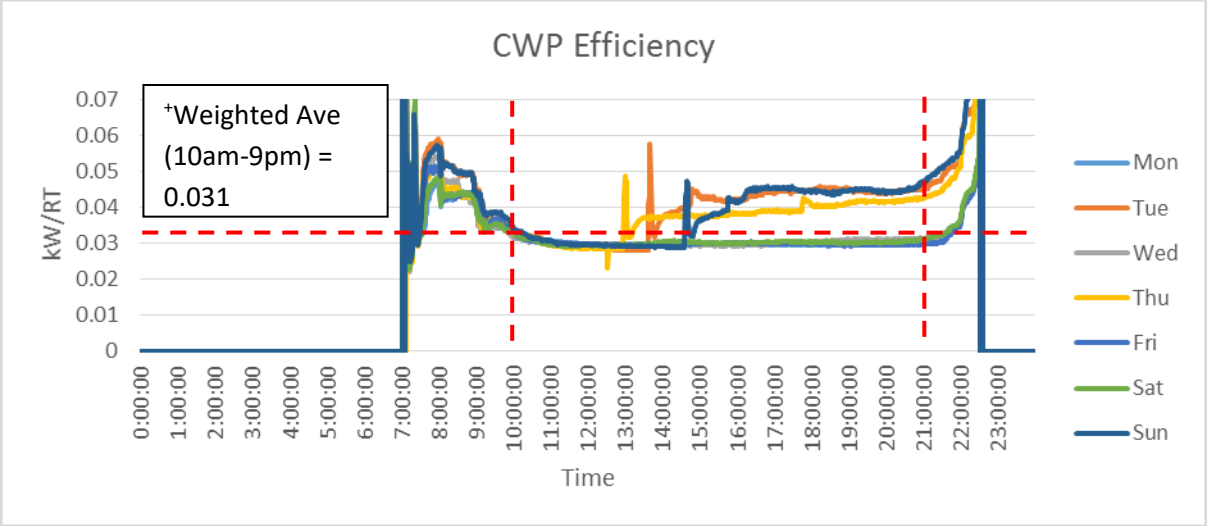

Figure 12: Super-imposed plot of daily condenser water pump efficiency kW/RT (Example)

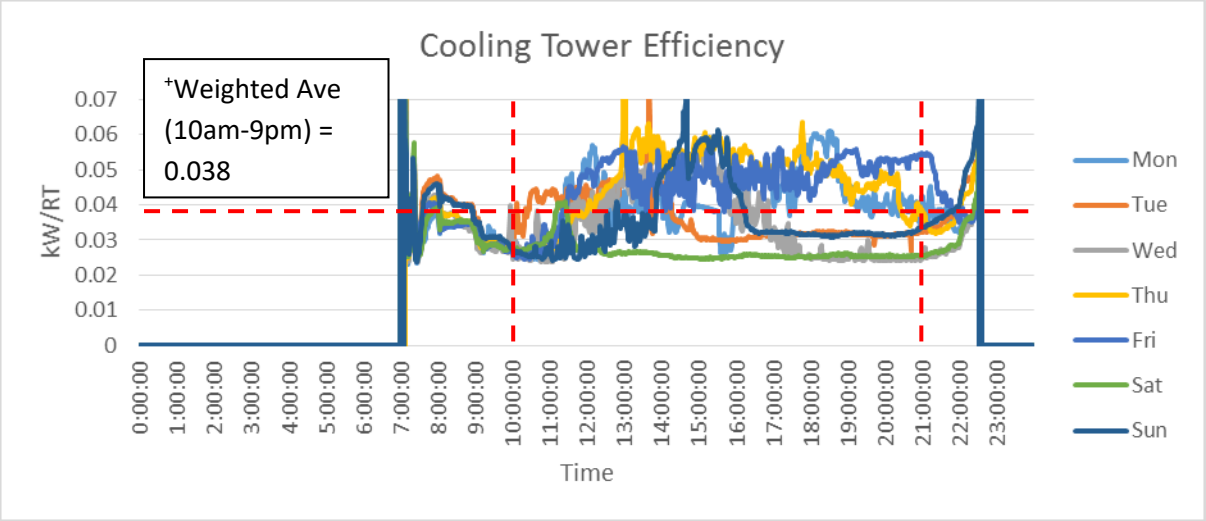

Figure 13: Super-imposed plot of daily cooling tower efficiency kW/RT (Example)

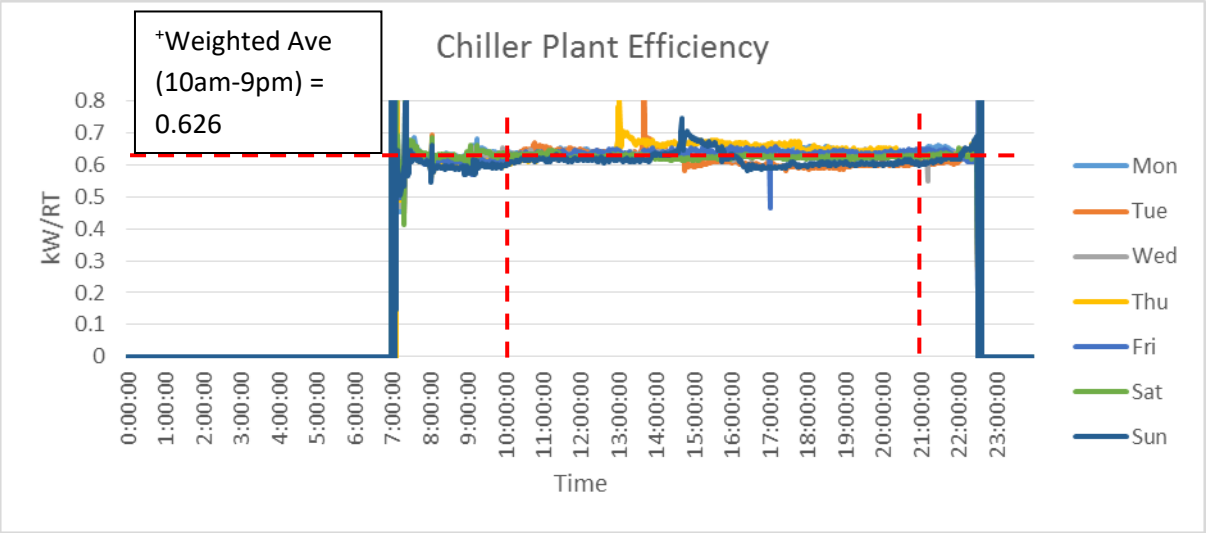

Figure 14:Super-imposed plot of daily chiller plant system efficiency kW/RT (Example)

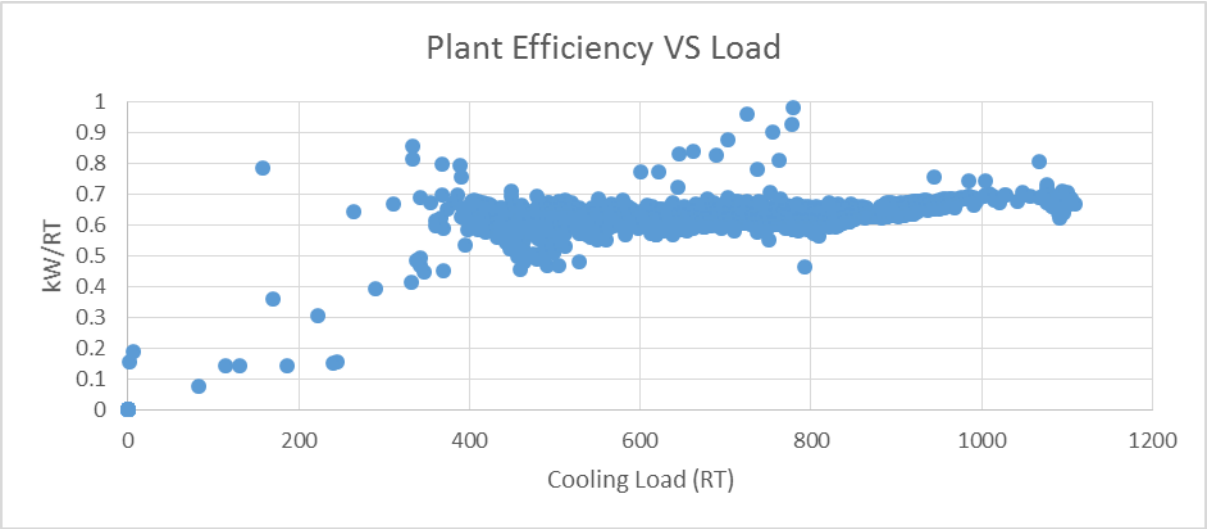

Figure 15: Scatter plot of chiller plant efficiency over cooling load (Example)

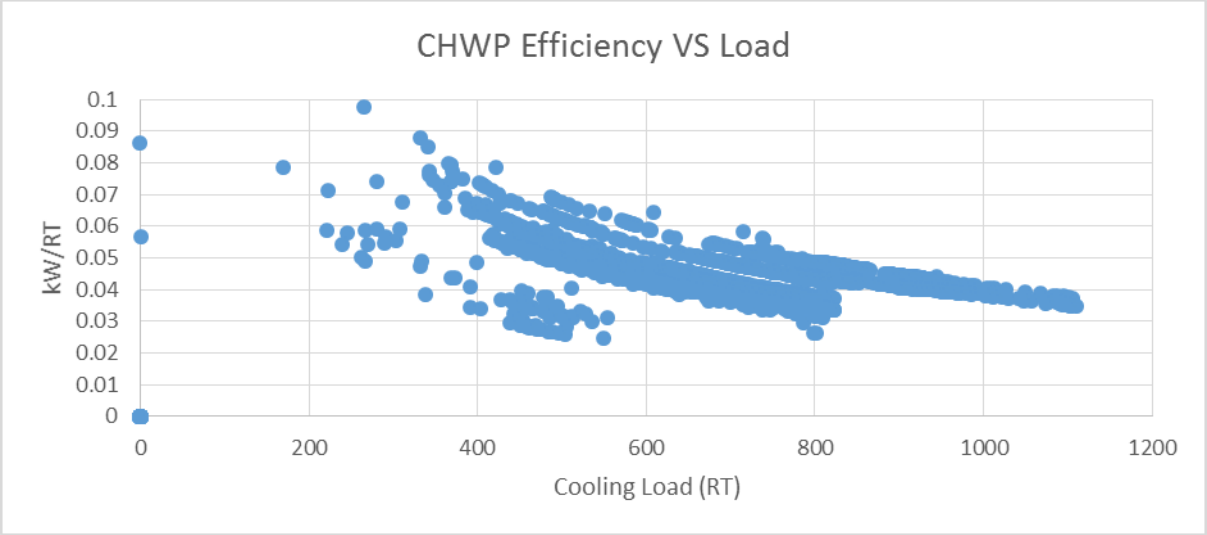

Figure 16: Scatter plot of chilled water pump efficiency over cooling load (Example)

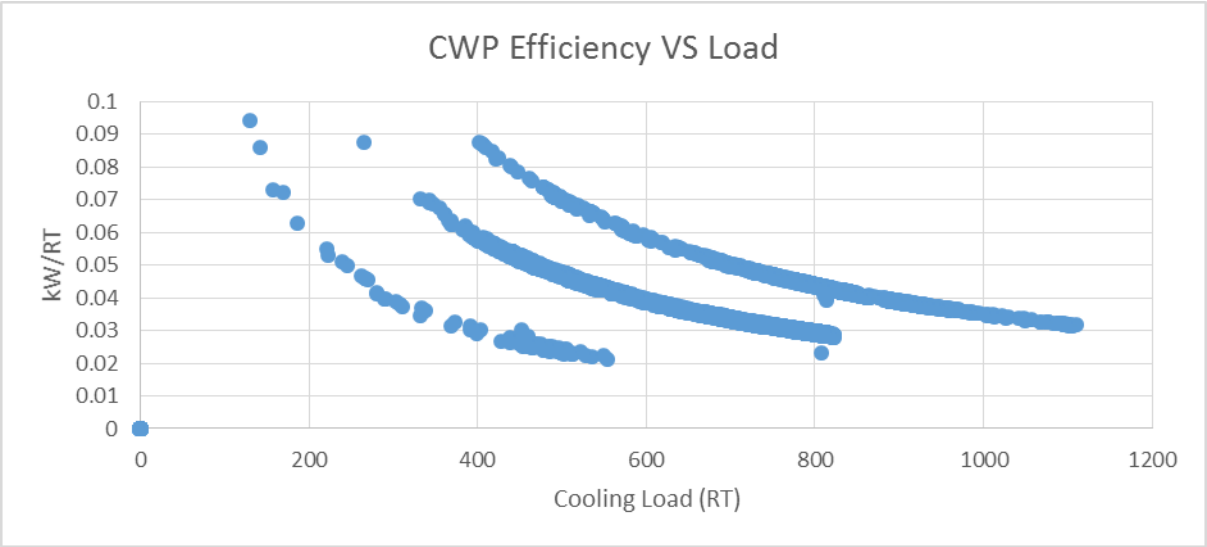

Figure 17: Scatter plot of condenser water pump efficiency over cooling load (Example)

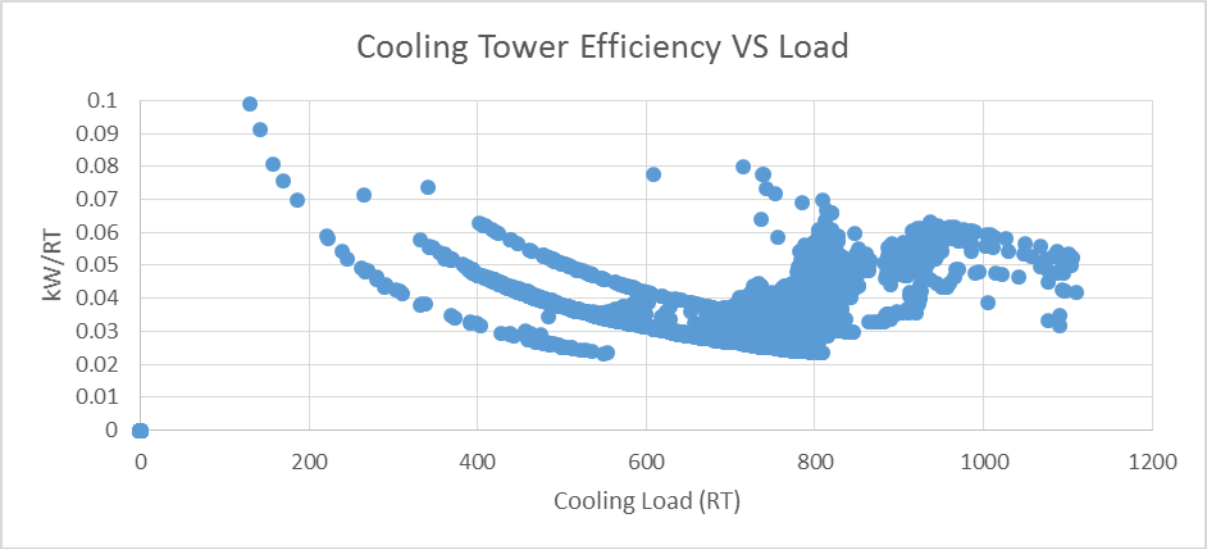

Figure 18: Scatter plot of cooling tower efficiency over cooling load (Example)

5.1 Summary of Chilled-Water Plant Operating Performance

Daily Average Reading	Period		Unit
	Daytime^	Night-time~	
Cooling Load			RTh
Cooling Load Density (Air-con area)			m2/RT
Power Consumption			kWh
Chilled water supply temperature			°C
Chilled water return temperature			°C
Chilled water delta T			°C
Chilled water flow rate			l/s
Chilled water flow rate vs cooling load			USgpm/RT
*Condenser heat rejection			HRT
*Condenser water supply temperature			°C
*Condenser water return temperature			°C
*Condenser water delta T			°C
*Condenser water flow rate			l/s
*Condenser water flow rate vs cooling load			USgpm/RT
Chiller(s) efficiency			kW/RT
Chilled water pump(s) efficiency			kW/RT
*Condenser water pump(s) efficiency			kW/RT
*Cooling tower(s) efficiency			kW/RT
Overall chiller plant efficiency			kW/RT

Table 5: Chilled Water Plant Performance Summary

*Not applicable to air-cooled Chilled Water Plant

~For hotels and other developments with 24-hour operations only; Night-time shall refer to the period from 11pm – 7am;

^ For hotels and other developments with 24-hour operations, day-time shall refer to the period from 7am – 11pm; for all other developments, daytime shall refer to the normal operating hours stipulated in subsection 4.1.1 of the Energy Audit Code.

5.2 Summary of Air-Side System Operating Performance

Daily Average Reading	Period		Unit
	Daytime^	Night-time~	
Air-side power consumption (a)			kWh
- Pre-AHU (measured)			kWh
- AHU (measured)			kWh
- FCU (nameplate or input power x op			kWh
Chiller plant cooling load (b)			RTh
Overall air-side efficiency (a / b)			kW/RT

Table 6: Air-Side System Performance Summary

5.3 Summary of Building Cooling System Operating Performance

Daily Average reading	Period		Unit
	Daytime^	Night-time~	
Overall air-side efficiency (where applicable)			**kW/RT**
Overall water-side efficiency			**kW/RT**
Total cooling system efficiency (TSE)			**kW/RT**

Table 7: Summary of Building Cooling System Operating Performance (including airside)

6.0 Summary of System Heat Balance (Chilled Water Plant)

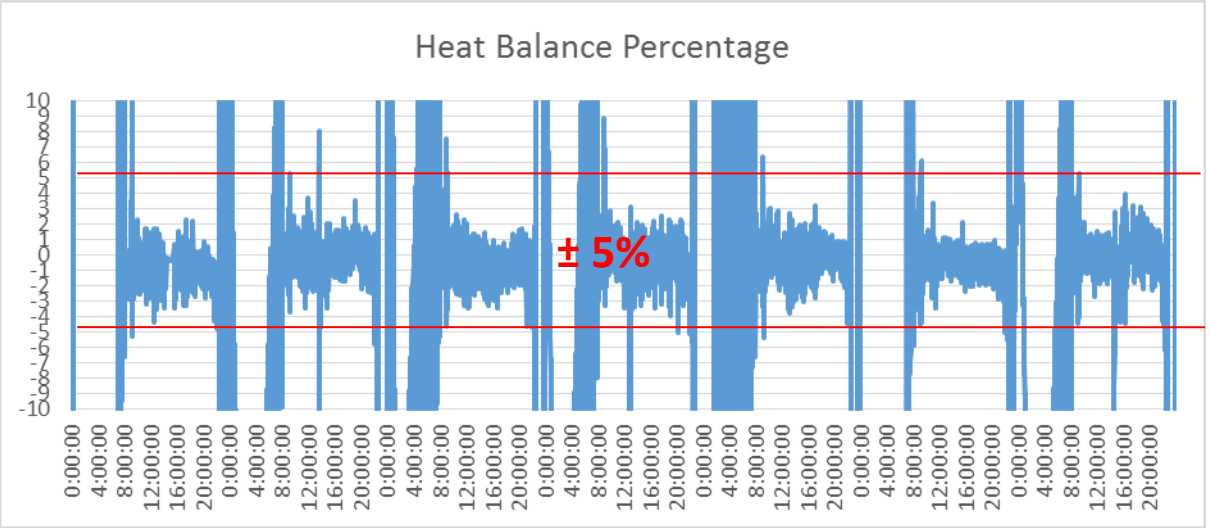

Figure 19: System Level Heat Balance Plot (Example)

	Quantity	Unit	Formula
Sum of total electrical energy used		kWh	(A)
Sum of total cooling produced		RTh	(B)
Sum of total heat rejected		RTh	(C)
Chiller Plant Efficiency		kW/RT	(A) / (B)
Total Heat Balance Data Count		-	(D)
Data Count > + 5% error		-	(E)
Data Count < - 5% error		-	(F)
Data Count within ±5% error		-	(G) = (D) – (E) – (F)
% Heat Balance within ±5% error		%	100 x (G) / (D)

Table 8: Heat Balance Summary

7.0 Schedule of Space Operating Conditions

(10 points Spot measurements)

		Normal operating room conditions		Measured		
	Room name (i.e. Air conditioned occupied/ common Spaces)	**Dry Bulb Temperature (°C)**	**Relative Humidity (%)**	***Dry Bulb Temperature (°C)**	***Relative Humidity (%)**	***CO2 Concentration (ppm)**
1	i.e. Office 1					
2	i.e. Office 2					
3	i.e. Meeting Room 1					
4	i.e. Meeting Room 2					
5						
6						
7						
8						
9						
10						

Table 9: Space Condition Schedule (Example)

* Any observation on over-cooling/ under-cooling and ventilating of space conditions should first be investigated and corrected before the energy audit is carry out. Refer to recommended limits of SS553 and SS 554.

8.0 Schedule of AHU Operating Conditions (5 typical units)

(Spot Measurements)

AHU no.	Parameters	Pre-Cooled AHU #1	Pre-Cooled AHU #2	AHU #1	AHU #2	AHU #3
1	Return Air Temp Setpoint(°C)	-	-			
2	Return Air Temp (°C)	-	-			
3	Supply Air Temp Setpoint(°C)	-	-			
4	Supply Air Temp (°C)					
5	Fan Speed Setpoint (Hz/%)					
6	Fan Speed (Hz /%)					
7	Rated (kW)					
8	Running (kW)					
9	Nameplate Airflow (CMH)	-	-			
10	Nameplate W/CMH	-	-			
11	CO2 Setpoint (ppm)	-	-			
12	CO2 (ppm)					
13	Outdoor Air Damper Opening (%)					
14	Outdoor Air Provision (Direct opening to external/ via PAHU or FAF)					
15	Filter Type/ Rating (Bag/ F7)					

Table 10: Schedule of AHU Operating Condition (5 Typical Units)

APPENDIX A

Checklist of Plant Operating Condition (for best practices)

	Yes	No	Actual value
Is the airside efficiency ≤ 0.2 kW/RT?			
Is Chilled water delta T >5.5 °C?			
Is the cooling tower approach temperature ≤ 2.0 °C as compared with outdoor wet bulb temperature?			
Is the Chilled water pump efficiency ≤ 0.03 kW/RT?			
Is the Condenser water pump efficiency ≤ 0.035 kW/RT?			
Is the Cooling Tower efficiency ≤ 0.03 kW/RT?			
Does Refrigerant Condenser approach within the range of 0.5 °C to 1.5 °C?			
Does Refrigerant Evaporator approach within the range of 0.5 °C to 1.5 °C?			

Table 11: Checklist of Plant Operating Condition (for best practices)

APPENDIX B

Temperature Sensor Verification Plots (Example)

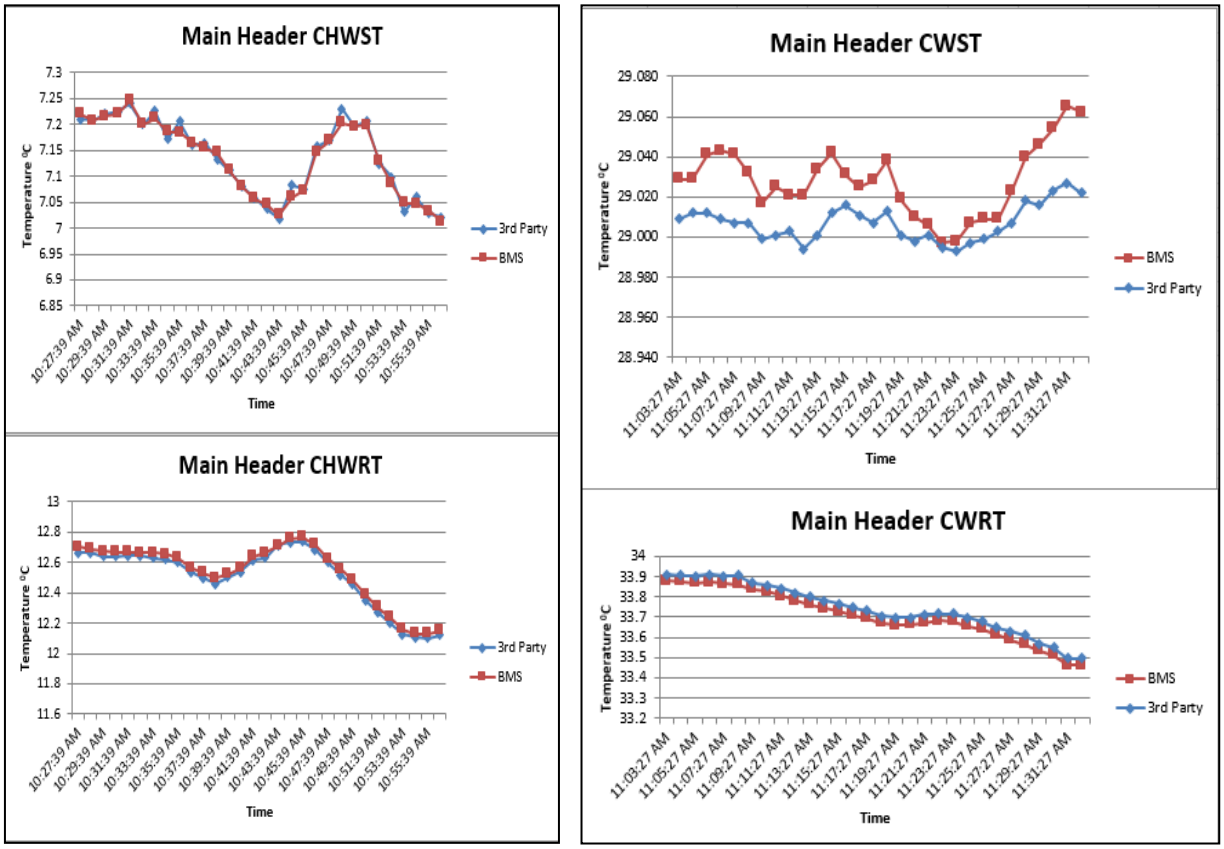

Figure 20: Temperature Verification Plots for Water-Cooled Chiller Plant System (Example)

Project Name: Enter name of project

Date of Verification: Enter date (dd/mm/yyyy)

Verification by: Enter name of PE (Mech)/Energy Auditor

Main Header Chilled Water Supply Temperature				Main Header Chilled Water Return Temperature			
Time	3rd party (°C)	BMS (°C)	ABS	Time	3rd party (°C)	BMS (°C)	ABS
10:27:39 AM	7.211	7.220	-0.009	10:27:39 AM	12.663	12.703	-0.040
10:28:39 AM	7.209	7.207	0.002	10:28:39 AM	12.665	12.690	-0.025
10:29:39 AM	7.221	7.216	0.005	10:29:39 AM	12.640	12.674	-0.034
10:30:39 AM	7.225	7.220	0.005	10:30:39 AM	12.640	12.671	-0.031
10:31:39 AM	7.240	7.246	-0.006	10:31:39 AM	12.642	12.668	-0.026
10:32:39 AM	7.200	7.200	0.000	10:32:39 AM	12.642	12.663	-0.021
10:33:39 AM	7.227	7.211	0.016	10:33:39 AM	12.628	12.662	-0.034
10:34:39 AM	7.172	7.186	-0.014	10:34:39 AM	12.622	12.653	-0.031
10:35:39 AM	7.205	7.184	0.021	10:35:39 AM	12.601	12.631	-0.030
10:36:39 AM	7.160	7.164	-0.004	10:36:39 AM	12.537	12.567	-0.030
10:37:39 AM	7.164	7.154	0.010	10:37:39 AM	12.499	12.532	-0.033
10:38:39 AM	7.133	7.146	-0.013	10:38:39 AM	12.460	12.497	-0.037
10:39:39 AM	7.111	7.111	0.000	10:39:39 AM	12.501	12.523	-0.022
10:40:39 AM	7.079	7.080	-0.001	10:40:39 AM	12.535	12.560	-0.025
10:41:39 AM	7.059	7.057	0.002	10:41:39 AM	12.614	12.640	-0.026
10:42:39 AM	7.037	7.046	-0.009	10:42:39 AM	12.631	12.664	-0.033
10:43:39 AM	7.019	7.026	-0.007	10:43:39 AM	12.712	12.710	0.002
10:44:39 AM	7.082	7.060	0.022	10:44:39 AM	12.732	12.758	-0.026
10:45:39 AM	7.076	7.073	0.003	10:45:39 AM	12.736	12.767	-0.031
10:46:39 AM	7.157	7.147	0.010	10:46:39 AM	12.683	12.718	-0.035
10:47:39 AM	7.170	7.169	0.001	10:47:39 AM	12.600	12.626	-0.026
10:48:39 AM	7.231	7.203	0.028	10:48:39 AM	12.518	12.557	-0.039
10:49:39 AM	7.198	7.196	0.002	10:49:39 AM	12.453	12.484	-0.031
10:50:39 AM	7.206	7.199	0.007	10:50:39 AM	12.351	12.392	-0.041
10:51:39 AM	7.125	7.128	-0.003	10:51:39 AM	12.273	12.305	-0.032
10:52:39 AM	7.098	7.085	0.013	10:52:39 AM	12.201	12.239	-0.038
10:53:39 AM	7.031	7.048	-0.017	10:53:39 AM	12.124	12.161	-0.037
10:54:39 AM	7.060	7.047	0.013	10:54:39 AM	12.106	12.131	-0.025
10:55:39 AM	7.028	7.032	-0.004	10:55:39 AM	12.100	12.129	-0.029
10:56:39 AM	7.021	7.013	0.008	10:56:39 AM	12.122	12.148	-0.026
Average	7.138	7.136	0.003	Average	12.508	12.537	-0.030
			Passed				Passed

Main Header Condenser Water Supply Temperature				Main Header Condenser Water Return Temperature			
Time	3rd party (°C)	BMS (°C)	ABS	Time	3rd party (°C)	BMS (°C)	ABS
11:03:27 AM	29.009	29.029	-0.020	11:03:27 AM	33.912	33.879	0.033
11:04:27 AM	29.012	29.029	-0.017	11:04:27 AM	33.907	33.876	0.031
11:05:27 AM	29.012	29.041	-0.029	11:05:27 AM	33.904	33.867	0.037
11:06:27 AM	29.009	29.043	-0.034	11:06:27 AM	33.910	33.874	0.036
11:07:27 AM	29.007	29.041	-0.034	11:07:27 AM	33.902	33.864	0.038
11:08:27 AM	29.007	29.032	-0.025	11:08:27 AM	33.906	33.862	0.044
11:09:27 AM	28.999	29.017	-0.018	11:09:27 AM	33.867	33.840	0.027
11:10:27 AM	29.001	29.025	-0.024	11:10:27 AM	33.858	33.826	0.032
11:11:27 AM	29.003	29.021	-0.018	11:11:27 AM	33.841	33.806	0.035
11:12:27 AM	28.994	29.021	-0.027	11:12:27 AM	33.818	33.781	0.037
11:13:27 AM	29.001	29.034	-0.033	11:13:27 AM	33.801	33.764	0.037
11:14:27 AM	29.012	29.042	-0.030	11:14:27 AM	33.780	33.744	0.036
11:15:27 AM	29.016	29.031	-0.015	11:15:27 AM	33.767	33.729	0.038
11:16:27 AM	29.011	29.025	-0.014	11:16:27 AM	33.746	33.709	0.037
11:17:27 AM	29.007	29.028	-0.021	11:17:27 AM	33.734	33.696	0.038
11:18:27 AM	29.013	29.038	-0.025	11:18:27 AM	33.706	33.672	0.034
11:19:27 AM	29.001	29.019	-0.018	11:19:27 AM	33.697	33.660	0.037
11:20:27 AM	28.998	29.010	-0.012	11:20:27 AM	33.698	33.662	0.036
11:21:27 AM	29.001	29.006	-0.005	11:21:27 AM	33.712	33.670	0.042
11:22:27 AM	28.995	28.997	-0.002	11:22:27 AM	33.718	33.681	0.037
11:23:27 AM	28.993	28.998	-0.005	11:23:27 AM	33.718	33.679	0.039
11:24:27 AM	28.997	29.007	-0.010	11:24:27 AM	33.699	33.658	0.041
11:25:27 AM	28.999	29.009	-0.010	11:25:27 AM	33.679	33.642	0.037
11:26:27 AM	29.003	29.009	-0.006	11:26:27 AM	33.648	33.615	0.033
11:27:27 AM	29.007	29.023	-0.016	11:27:27 AM	33.628	33.586	0.042
11:28:27 AM	29.018	29.040	-0.022	11:28:27 AM	33.611	33.564	0.047
11:29:27 AM	29.016	29.046	-0.030	11:29:27 AM	33.568	33.535	0.033
11:30:27 AM	29.023	29.054	-0.031	11:30:27 AM	33.549	33.511	0.038
11:31:27 AM	29.027	29.065	-0.038	11:31:27 AM	33.498	33.463	0.035
11:32:27 AM	29.022	29.062	-0.040	11:32:27 AM	33.496	33.462	0.034
Average	29.007	29.028	-0.021	Average	33.743	33.706	0.037
			Passed				Passed

Table 12: Verification of temperature sensors

APPENDIX C

Total Cooling System Efficiency (Example)

Average reading	Period		Unit
	Daytime[See Note 2]	Night-time[See Note 3]	
Overall air-side efficiency [See note 1]			kW/RT
Overall water-side efficiency			kW/RT
Total cooling system efficiency			kW/RT

Table 13: Total Cooling System Efficiency (including airside system)

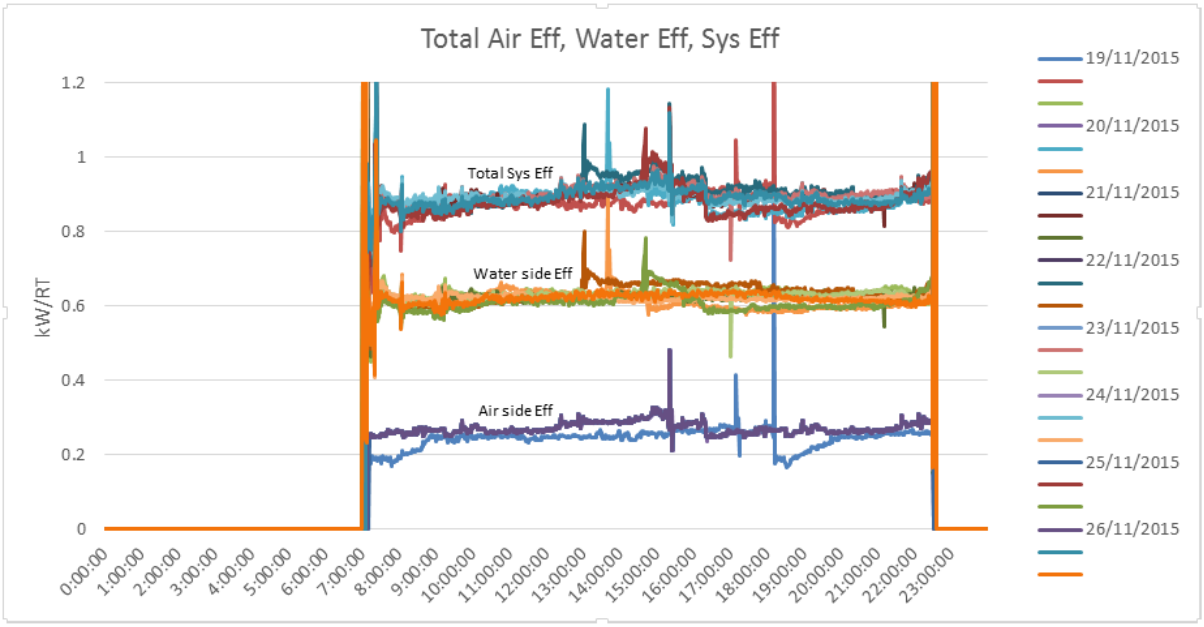

Figure 21: Super-imposed plot of daily total cooling system efficiency kW/RT (Example)

Note (1)The computation of the air-side efficiency is applicable to :

(a) buildings for which the design score submission under the ESM Regulations 2013 were made on or after 1 June 2022;

(b) buildings where the applications for planning permission were submitted to the competent authority under the Planning Act 1998 on or after 1 December 2021 under ES Regulations 2008; and

(c) buildings wholly or partly on land sold on or after 30 June 2022 under the GLS Programme and subject to the ES Regulations 2008.

Note (2) - For hotels and other developments with 24-hour operations, day-time shall refer to the period from 7am – 11pm; for all other developments, daytime shall refer to the normal operating hours stipulated in subsection 4.1.1 of the Energy Audit Code.

Note (3) - For hotels and other developments with 24-hour operations only; Night-time shall refer to the period from 11pm – 7am.