

GREEN MARK INCENTIVE SCHEME FOR EXISTING BUILDINGS GUIDELINES FOR HEALTH CHECK REPORT

1. Cover Page

- Report title
- Name of building (which has been audited)
- Location / Address of building
- Iconic photo of the building (optional)
- Date of report
- Details of ESCO/ Audit Company
- Details of **BCA Registered Energy Auditor** / M&E Professional Engineer
- Endorsement / Signature of **BCA Registered Energy Auditor** / M&E Professional Engineer
- Statement by the building owner accepting the report and reviewed the results and recommendations
- Name, designation and signature of building owner's representative accepting the report.

2. Table of Contents

- Executive Summary
- Introduction
- Methodology and instrumentation
- Method of Statement
- Data analysis and findings including graphs, plots and explanations
- Summary of recommendations
- Conclusion
- Appendices

3. Executive Summary

All information in the Executive Summary should be drawn from the detailed information in the full report. The Executive Summary should contain a brief description of the audit, including:

- Name of building owner and location of building audited
- Objectives of audit
- Key systems and equipment analysed
- Dates of audit
- Summary of audit findings and recommendation on overall and major components of the central plant, including estimated cost, energy savings and payback period.

4. Introduction

- Objectives of audit – e.g. to assess the performance of the existing chiller plant in terms of building cooling load and system efficiency; and identify potential energy savings.
- Brief description of building audited – number of floors, GFA, air-conditioned areas, type of usage, occupancy, hours of operation, year built, etc.
- Information on tenants in facility or building audited (If applicable)
- Scope of audit, elaborating what systems or equipment were studied

5. Methodology and Instrumentation

- Declaration of code compliance (ASHRAE Standard 22, AHRI Standard 550/590, SS 591)
- Instrumentation specification table (see example below)
- Proposed instrumentation plan in detail; Schematics or point listings of where instruments are installed.
- Detailed instrument installation and measurement procedure/method statement.
- Pictures and maps showing the locations of the installed instruments and sensors
- All sensors must be calibrated before installation. Manufacturers' calibration data may be sufficient as long as the installation conditions match the conditions of calibration. Manufacturers' calibration data should include documents of traceability to the calibration facility and, ultimately, traceability to national standards.
- Measurement error analysis (mandatory)

Point Description	Sensor type	Installation location	Measurement / Calibration range	Measurement uncertainty (%) / End-to-end accuracy	Last calibration Date	Trend interval (min)
Chilled water pipe / header						
CHWS temperature	10K Ω Thermistor	CHW header	0°C to 50°C	$\pm 0.03^\circ\text{C}$	15/8/2012	1
CHWR temperature	10K Ω Thermistor	CHW header	0°C to 50°C	$\pm 0.03^\circ\text{C}$	15/8/2012	1
CHW flowrate	In-line flowmeter	CHW header	30l/s to 200l/s	0.5%	25/10/2012	1
Condenser water pipe / header						
CWS temperature	10K Ω Thermistor	CW header	0°C to 40°C	$\pm 0.03^\circ\text{C}$	15/8/2012	1
CWR temperature	10K Ω Thermistor	CW header	0°C to 40°C	$\pm 0.03^\circ\text{C}$	15/8/2012	1
CW flowrate	In-line flowmeter	CW header	30l/s to 200l/s	0.5%	25/10/2012	1
Chiller						
Power consumption	True RMS 3 phase	Chiller electrical panel	0 – 350 kW	0.5%	8/9/2012	1
Chilled water pump						
Power consumption	True RMS 3 phase	CHWP electrical panel	20 – 200 kW	0.5%	8/9/2012	1
Condenser water pump						
Power consumption	True RMS 3 phase	CWP electrical panel	20 – 200 kW	0.5%	8/9/2012	1
Cooling tower						
Power consumption	True RMS 3 phase	CT electrical panel	15 – 150 kW	0.5%	8/9/2012	1

Instrument Specification Table (example)

6. Calculation Methodology

- 6.1. The calculation of the chiller plant cooling load, system efficiency (kW/Ton, COP etc) must follow the ASHRAE Guideline 22 or equivalent.
- 6.2. The calculation of the measurement error for all the instrument & auxiliary instrument used.

- (a) Calculation of the overall uncertainty of measurement of the resultant chiller plant in kW/RT to be within $\pm 5\%$ of the true value based on instrumentation specification and calibration certificates.
- (b) Detailed method statement explaining how the required degree of accuracy was achieved with the instruments and data acquisition hardware employed.
- (c) Data required to establish system performance must be sampled and acquired simultaneously and continuously for a minimum of 2 weeks at one-minute intervals

6.3. Measurement total error analysis by using the formula of ASHRAE Guideline 22.

6.4. The computation of the system heat balance of the chilled water plant shall be in accordance to AHRI 550/590.

7. Data Analysis and Findings

7.1. Dates of data collection and logging

7.2. Description of system or equipment audited, their capacities and ratings, design and operating conditions, equipment schedules, variable speed drives, chiller plant schematic, operating hours, etc

ID	Make/Brand	Cooling Capacity (RT)	Name plate motor (kW)	Chilled water flowrate (l/s)	Chilled water LWT	Chilled water ΔT	Rated Efficiency kW/RT	Year Installed
CH-1	Trane Centrifugal	1000	150	151.4	6.7°C	5.5°C	0.55	2012
CH-2	Carrier VSD Screw	500	90	75.7	6.7°C	5.5°C	0.52	2012

Summary of Chiller Information (Example)

ID	Name plate motor (kW)	Pump Head (m)	Flow rate (L/S)	Pump/ Fan efficiency	Motor Efficiency	Year Installed
CHWP -1	55	30	151.4	85%	95%	2012
CHWP-2	30	30	75.7	85%	95%	2012
CWP-1	45	20	189.2	85%	95%	2012
CWP-2	22	20	94.6	85%	95%	2012

Summary of Pumps Information (Example)

ID	LWT (°C)	EWT (°C)	Wet Bulb (°C)	Water Flow rate (L/S)	Name plate fan motor (kW)	Fan efficiency	Motor Efficiency	Year Installed
CT-1	35°C	30°C	27.5°C	130	7.5 x 3	75%	92%	2012
CT-2	35°C	30°C	27.5°C	130	5.5 x 2	75%	92%	2012

Summary of Cooling Towers Information (Example)

Operating hours	Chillers	CHW pumps	CW pumps	CT
Monday to Friday (8:00 am to 6:00 pm)	CH-1	CHWP-1	CWP-1	CT-1
Monday to Friday (6:00 pm to 10:00 pm)	CH-2	CHWP-2	CWP-2	CT-2
Saturday (8:00 am to 13:00 pm)	CH-2	CHWP-2	CWP-2	CT-2

Operation hours for Chiller Plant (Example)

7.3. Performance of system audited

Building cooling load (average)		RT
Chiller(s) efficiency		KW/RT
Chilled water pump(s) efficiency		KW/RT
Condenser water pump(s)*		KW/RT
Cooling tower (s)Efficiency*		KW/RT
Overall chiller plant efficiency		KW/RT

Summary of Chilled Water Plant Performance

(a) Overall Chiller Plant (Plots, graphs, explanations)

- (i) Plot of cooling load (RT) profile over at least two weeks in two plots (weekly).
- (ii) Super-imposed plot of daily cooling load (RT) profile; daily plots should be fine-lined and in different colours
- (iii) Superimposed plot of daily chiller plant system efficiency
- (iv) Histogram of cooling load occurrences
- (v) Scatter plot of chiller plant efficiency over cooling load
- (vi) Plot Power (kW) vs Cooling load (RT)
- (vii) Chilled water and condenser water profiles (USgpm/RT) vs RT

(b) Chilled water temperature, flow rate and pressure differential profile

- (i) Each chiller (if common header is not available)
 - Supply and return temperature profiles as well as temperature differential profile (super-imposed)
 - Chilled water flow rate profile
- (ii) Main chilled water supply and return header (by-pass connection should be considered to capture the actual conditions)
 - Supply and return temperature profiles (super-imposed)
 - Chilled water flow rate
 - Pressure differential

(c) Condenser water temperature, flow rate and pressure differential profile

- (i) Each chiller (if common header is not available)
 - Supply and return temperature profiles as well as temperature differential profile (super-imposed)
 - Condenser water flow rate profile
- (ii) Main condenser water supply and return header
 - Supply and return temperature profiles (super-imposed)
 - Chilled water flow rate
 - Pressure differential

(d) Chiller : Average values in a table format (for system)

Parameter	Design	Operating conditions
CHW Supply Temp (°C)		
CHW Return Temp (°C)		
CHW Flow rate (l/s)		
CW Supply Temp (°C)		
CW Return Temp (°C)		
CW Flow rate (l/s)		
Operating Capacity (Ton)		
Operating Power (kW)		
Operating Efficiency (kW/Ton)		

(e) Chilled water pumps

Parameter		Flow Rate (based on header flow rate unless it is not possible to measure at the header) (l/s)	Pump Head (m)	Motor Power (kW)	Efficiency (kW/Ton)
Design	CHWP 1				
	CHWP 2				
Actual	CHWP 1				
	CHWP 2				

(f) Condenser water pumps

Parameter		Flow Rate (based on header flow rate unless it is not possible to measure at the header) (l/s)	Pump Head (m)	Motor Power (kW)	Efficiency (kW/Ton)
Design	CWP 1				
	CWP 2				
Actual	CWP 1				
	CWP 2				

(g) Power measurement : kW profile for each chiller (or system)(h) For pumping systems with variable speed drives : kW vs time plots

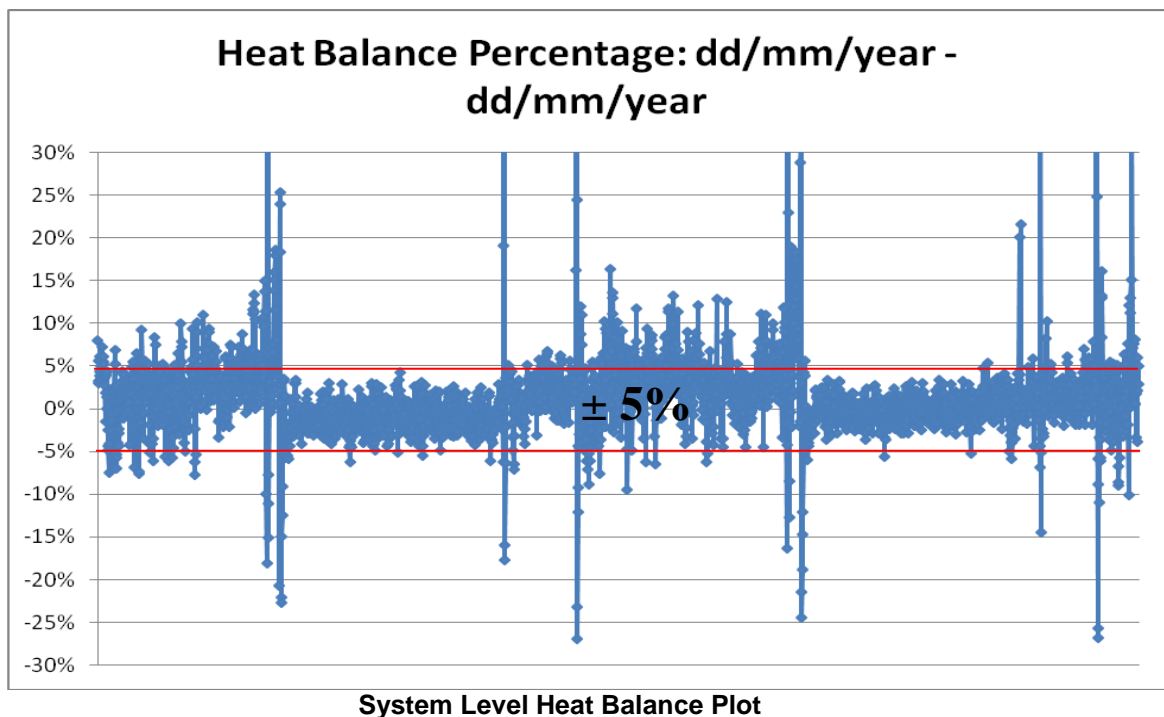
(i) Cooling towers : General observation and improvement recommendations

7.4. Findings and observations

7.5. Heat balance

(i) System level heat balance plot

(ii) Heat balance summary



	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)

Heat Balance Summary

8. Conclusions & Recommendations

- Summary of recommendations on area of improvement, in table format
- Brief description of the present situation and shortcomings identified related to Chiller System Efficiency.

9. Appendices

Information of significant importance, which cannot be presented as a part of the text report (because of number of pages, quality of presentation, etc.) should be presented in appendices.

The appendices should include:

- Piping schematics of chiller plant
- Electrical single line for chiller plant equipment
- Schematic / Layout plan showing the chiller plant and equipment
- Details of instrumentation used – parameters monitored and duration of monitoring for each parameter
- Data plots of performance of systems or equipment audited
- Energy efficiency of major equipment compared against industrial benchmarks

10. General Notes to the Report

- Documentation – All numbers related to the results should be supported by information showing how they were derived.
- All calculations in the report should be checked for mathematical accuracy.
- SI units must be used in all parts of the report.
- Measurement and instrumentation accuracy - measurements should adhere to ASHRAE Guidelines 22.
- Grammar and style – The report should be written in proper prose. The language should be clear, concise and understandable.
- All graphs and plots should be properly labelled and show the dates when the readings were taken.
- Examples shown in this guideline serve as a guide; actual tables should show more detailed information where possible.
- The report can be printed on both sides to save paper.
- The CD-ROM, containing the raw measurement data in a readable file format, shall be copied and sent to BCA with the Report.