

**Energy Saving Report For  
“CQM”  
Automatic Tube Cleaning System**

**for**

**THE PARK LANE  
HONG KONG**

**Prepared by -**

**Richmond Consulting Engineers**

***3 January 2005***

# Energy Saving Report for “CQM” Automatic Tube Cleaning System The Park Lane Hong Kong

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## **INTRODUCTION**

The Park Lane is one of the most splendid hotels located in Causeway Bay, next to Victoria Park. The chiller plant of the hotel have a total of 1500 tonnage cooling capacity and are served by **3 x 500RT** water cooled chiller. The condensing system is using fresh water cooling tower.

As the condenser is an important component in the chilled water system, the operating condition of the condenser is the key factor that affects the efficiency of the unit. However, the condenser will be seriously deteriorated by the debris and foulants accumulated in the tubes of the condensers. When fouling and scaling in the condenser increase, the heat transfer efficiency will be decrease, resulting in more power consumption of the chiller.

The Engineering Department of the hotel identified the above problem and started to install an automatic tube cleaning system called “CQM” for chiller #1 in October 2003. The system has been running for 12 months. Feedback from operators and engineers are good, which can be easily reflected by:

1. Refrigerant Temperature is closer to the condenser water leaving temperature than before.
2. Less frequent for manual cleaning.

From the above facts, operation cost of the condenser will be lower. In fact, the condenser is maintaining its cleanliness, therefore the heat transfer is more efficient which result is energy saving. In this report, logged system data will be used for energy study and the substantial cost saving can be obtained.

## **OBJECTIVES**

The objective of this report is to calculate the energy saving of the chiller that “CQM” was installed. It is then used to evaluate the Return on Investment for chiller #2 and chiller #3 that “CQM” had not been installed yet.

**ANALYSIS APPROACH**

***COP Comparison Approach***

The improvement of energy efficiency in energy management for chiller is concerned with the Coefficient of Performance (COP). The approach used in this report to study the improvement of COP after the installation of CQM.

Chiller #1 is the one installed with CQM and Chiller #3 is the one that without CQM. In this approach, we shall compare the COP of Chiller #1 and Chiller #3. Both chillers’ capacity is 1583kW, and put into operation almost at same time. We assume that both Chiller #1 and Chiller #3 are running at the same efficiency when without CQM.

The average percentage of energy saving can be calculated using the following formula:

$$\text{Average \%Save} = \frac{\frac{1}{\overline{COP_3}} - \frac{1}{\overline{COP_1}}}{\frac{1}{\overline{COP_3}}} \dots\dots\dots(1)$$

where,  $\overline{COP_3}$  = Average Coefficient of Performance of Chiller #3 that without CQM installation  
 $\overline{COP_1}$  = Average Coefficient of Performance of Chiller #1 that with CQM installation

By the definition of coefficient of performance (COP) – cooling, it is the ratio of the rate of heat removal to the rate of energy input. The following equations shall be used to calculate the COP:-

$$COP = \frac{MC(T_e - T_l)}{WD} \dots\dots\dots(2)$$

$$WD = \sqrt{3} \times V \times I \times PF \dots\dots\dots(3)$$

- where, M = Mass flow rate of chilled water (kg/s)
- C = Specific heat capacity of water (kJ/kg)
- T<sub>e</sub> = Entering chilled water temperature (°C)
- T<sub>l</sub> = Leaving chilled water temperature (°C)
- WD = Power Consumption of Chiller (kW)
- V = Voltage (V)
- I = Current (A)
- PF = Power Factor

We assume that the PF = 0.9 and constant M = 70 for the above.

Logged data from October 2003 to September 2004 of the above parameters for Chiller #3 and Chiller # 1 were collected for the analysis.

***Temperature Difference Comparison Approach***

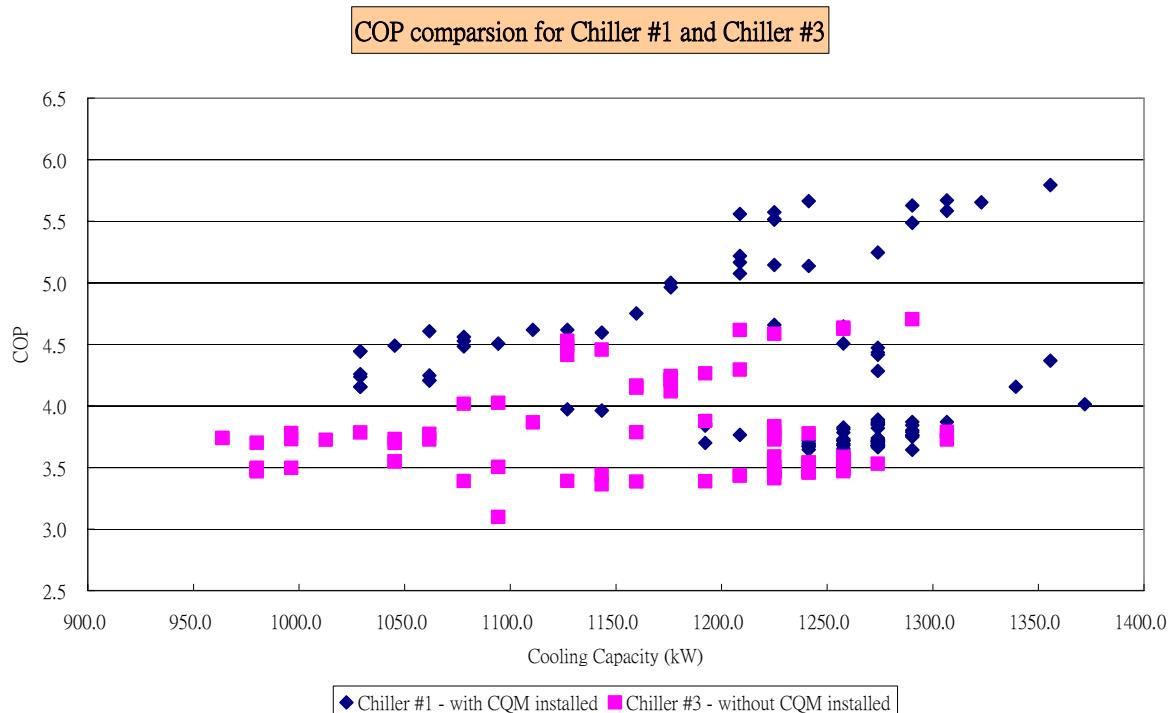
On the other hand, the effectiveness of CQM can be easily understood by comparing the Condenser Refrigerant Temperature (CRT) and Leaving Condensing Water Temperature (LCWT) Differences.

## RESULTS AND ANALYSIS

### *COP Comparison Approach*

COP can be compared when the both Chiller #1 and Chiller #3 are running at the same conditions. Chiller #1 is installed with CQM, and Chiller #3 is without CQM. The data are collected after October 2003, the time period that CQM had been installed for Chiller #1.

According to Figure 1, the COP of Chiller #1 with CQM system is generally above that of Chiller #3 without CQM system.



**Fig. 1 COP comparison for Chiller #1 and Chiller #3 at different cooling capacity**

By using equations (2) & (3), the calculated average COP for Chiller #3 is 3.7 and the average COP for Chiller #1 is 4.2.

Thus, by equation (1), the average percentage of energy saving = 11.9%

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***Temperature Difference Comparison Approach***

On the other hand, the effectiveness of CQM can be easily understood by comparing the Condenser Refrigerant Temperature (CRT) and Leaving Condensing Water Temperature (LCWT) Differences. The table below summarizes the above findings.

	<b>Chiller #3 without CQM installation</b>	<b>Chiller #1 after CQM installation</b>
<b>Average (CRT – LCWT)</b>	<b>6.0°C</b>	<b>3.8°C</b>

**Table 1. Average Condenser Refrigerant Temperature (CRT) and Leaving Condensing Water Temperature (LCWT) Differences**

The average temperature difference dropped to 3.8°C after CQM installation. It drops about 36.7% when comparing to the chiller #3 that without CQM installation. The narrowing in temperature difference implies the heat transfer efficiency between condensing water and refrigerant was greatly improved.

## **CONCLUSION**

From the above results, the operating efficiency and performance of the chiller were improved after installation of automatic tube cleaning system “CQM”.

In the COP comparison approach, the percentage of energy saving was 11.9% and the average COP was improved from 3.7 to 4.2.

In the temperature difference comparison approach, the average temperature difference for Chiller #1 (with CQM installed) is only 3.8<sup>0</sup>C while the average temperature difference for Chiller #3 is 6.0<sup>0</sup>C (without CQM installed). The narrowing in temperature difference implies the heat transfer efficiency between condensing water and refrigerant has been greatly improved.

In general, CQM automatic tube cleaning system helps in maintaining the cleanliness of the Condenser Units, thus keeping the peak efficiency of the chiller and hence save energy.

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
22/7/2004	3	1:00:00	451	52.0	44.5	86.5	92.5	96.0	267.2	1225.0	4.6
22/7/2004	3	2:00:00	471	51.9	44.7	89.3	95.3	99.4	279.0	1176.0	4.2
22/7/2004	3	3:00:00	472	51.8	44.6	89.2	95.4	99.5	279.6	1176.0	4.2
22/7/2004	3	4:00:00	472	51.7	44.6	89.7	95.2	99.3	279.6	1159.7	4.1
22/7/2004	3	5:00:00	482	51.8	44.6	89.9	95.9	99.9	285.5	1176.0	4.1
22/7/2004	3	6:00:00	473	50.6	44.6	89.3	95.5	99.4	280.2	980.0	3.5
22/7/2004	3	7:00:00	481	51.0	44.9	89.0	95.4	99.5	284.9	996.3	3.5
22/7/2004	3	8:00:00	477	51.0	44.6	86.6	93.1	97.3	282.6	1045.3	3.7
22/7/2004	3	9:00:00	555	52.4	44.8	87.2	94.9	100.6	328.8	1241.3	3.8
22/7/2004	3	10:00:00	598	52.8	45.3	87.9	96.3	102.7	354.2	1225.0	3.5
22/7/2004	3	11:00:00	592	52.5	44.9	86.5	95.0	101.5	350.7	1241.3	3.5
22/7/2004	3	12:00:00	600	53.0	45.4	86.5	95.0	101.5	355.4	1241.3	3.5
22/7/2004	3	13:00:00	608	53.4	45.7	86.5	95.2	101.8	360.2	1257.7	3.5
22/7/2004	3	14:00:00	602	53.2	45.6	86.3	94.9	101.4	356.6	1241.3	3.5
22/7/2004	3	15:00:00	598	53.1	45.5	86.0	94.7	101.2	354.2	1241.3	3.5
22/7/2004	3	16:00:00	610	53.4	45.7	86.2	94.9	101.5	361.3	1257.7	3.5
22/7/2004	3	17:00:00	612	53.4	45.7	86.2	95.0	101.8	362.5	1257.7	3.5
22/7/2004	3	18:00:00	609	53.3	45.5	86.7	95.0	101.7	360.7	1274.0	3.5
22/7/2004	3	19:00:00	604	53.0	45.4	86.5	95.0	101.6	357.8	1241.3	3.5
23/7/2004	3	1:00:00	453	51.3	44.7	86.3	92.4	96.3	268.3	1078.0	4.0
23/7/2004	3	2:00:00	475	51.8	44.4	89.5	95.8	99.7	281.4	1208.7	4.3
23/7/2004	3	3:00:00	472	51.7	44.4	89.4	95.7	99.8	279.6	1192.3	4.3
23/7/2004	3	4:00:00	470	51.5	44.4	89.3	95.4	99.7	278.4	1159.7	4.2
23/7/2004	3	5:00:00	468	51.6	44.4	89.2	95.2	99.9	277.2	1176.0	4.2
23/7/2004	3	6:00:00	477	50.4	44.4	88.8	95.0	98.8	282.6	980.0	3.5
23/7/2004	3	7:00:00	497	51.1	44.7	89.2	96.0	100.3	294.4	1045.3	3.6
23/7/2004	3	8:00:00	497	51.1	44.7	89.2	96.0	100.3	294.4	1045.3	3.6
23/7/2004	3	9:00:00	545	52.3	44.8	86.7	94.5	100.3	322.8	1225.0	3.8
23/7/2004	3	10:00:00	592	52.9	44.9	87.2	95.8	102.1	350.7	1306.7	3.7
23/7/2004	3	11:00:00	598	52.8	45.1	86.0	94.6	101.2	354.2	1257.7	3.6



**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
23/7/2004	3	12:00:00	598	52.8	45.1	86.0	94.6	101.2	354.2	1257.7	3.6
23/7/2004	3	13:00:00	608	53.4	45.7	86.2	94.9	101.5	360.2	1257.7	3.5
23/7/2004	3	14:00:00	596	53.8	46.2	86.2	94.9	101.5	353.0	1241.3	3.5
23/7/2004	3	15:00:00	604	53.7	46.1	86.0	94.6	101.2	357.8	1241.3	3.5
23/7/2004	3	16:00:00	600	53.6	46.0	85.7	94.4	100.9	355.4	1241.3	3.5
23/7/2004	3	17:00:00	600	53.4	45.8	85.6	94.3	100.6	355.4	1241.3	3.5
24/7/2004	3	1:00:00	459	52.2	44.5	85.3	91.6	96.8	271.9	1257.7	4.6
24/7/2004	3	2:00:00	458	52.1	44.4	85.2	91.5	96.7	271.3	1257.7	4.6
24/7/2004	3	3:00:00	420	51.6	44.7	84.7	90.5	94.8	248.8	1127.0	4.5
24/7/2004	3	4:00:00	424	51.7	44.8	84.8	90.4	94.8	251.2	1127.0	4.5
24/7/2004	3	5:00:00	435	50.3	44.4	84.8	90.7	95.5	257.7	963.7	3.7
24/7/2004	3	6:00:00	435	50.3	44.4	84.8	90.7	95.5	257.7	963.7	3.7
24/7/2004	3	7:00:00	459	50.9	44.6	84.5	90.9	96.1	271.9	1029.0	3.8
24/7/2004	3	8:00:00	459	50.8	44.6	84.9	91.3	96.5	271.9	1012.7	3.7
24/7/2004	3	9:00:00	551	52.3	44.8	86.6	94.5	100.0	326.4	1225.0	3.8
24/7/2004	3	10:00:00	555	52.2	44.7	86.7	94.7	100.6	328.8	1225.0	3.7
24/7/2004	3	11:00:00	592	52.3	44.7	85.4	94.0	100.3	350.7	1241.3	3.5
24/7/2004	3	12:00:00	600	52.9	45.3	85.2	93.8	100.3	355.4	1241.3	3.5
24/7/2004	3	13:00:00	594	52.9	45.2	84.6	93.4	100.0	351.9	1257.7	3.6
24/7/2004	3	14:00:00	604	52.9	45.2	84.6	93.4	100.0	357.8	1257.7	3.5
24/7/2004	3	15:00:00	600	53.1	45.4	85.3	94.1	100.6	355.4	1257.7	3.5
24/7/2004	3	16:00:00	602	52.9	45.2	84.6	93.5	100.3	356.6	1257.7	3.5
24/7/2004	3	17:00:00	606	52.8	45.2	85.3	94.0	100.6	359.0	1241.3	3.5
25/7/2004	3	1:00:00	459	51.3	44.6	85.8	92.1	95.8	271.9	1094.3	4.0
25/7/2004	3	2:00:00	442	51.9	44.5	84.7	90.7	95.3	261.8	1208.7	4.6
25/7/2004	3	3:00:00	433	51.5	44.5	84.8	90.6	95.1	256.5	1143.3	4.5
25/7/2004	3	4:00:00	431	51.4	44.5	84.8	90.5	94.8	255.3	1127.0	4.4
25/7/2004	3	5:00:00	475	50.4	44.4	88.6	95.0	99.4	281.4	980.0	3.5
25/7/2004	3	6:00:00	475	50.4	44.4	88.6	95.0	99.4	281.4	980.0	3.5
25/7/2004	3	7:00:00	447	50.8	44.8	84.7	90.9	95.8	264.8	980.0	3.7
25/7/2004	3	8:00:00	451	50.9	44.8	84.7	90.9	95.8	267.2	996.3	3.7
25/7/2004	3	9:00:00	473	51.2	44.8	85.1	91.8	96.0	280.2	1045.3	3.7

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
25/7/2004	3	10:00:00	590	52.6	45.1	87.2	95.8	102.4	349.5	1225.0	3.5
25/7/2004	3	11:00:00	596	52.3	44.7	85.2	93.8	100.3	353.0	1241.3	3.5
25/7/2004	3	12:00:00	604	52.6	44.9	85.4	94.2	100.6	357.8	1257.7	3.5
25/7/2004	3	13:00:00	600	52.8	45.1	85.5	94.3	100.9	355.4	1257.7	3.5
25/7/2004	3	14:00:00	604	53.6	45.9	86.0	94.9	101.5	357.8	1257.7	3.5
25/7/2004	3	15:00:00	596	52.3	45.6	86.0	94.9	100.9	353.0	1094.3	3.1
25/7/2004	3	16:00:00	561	51.3	44.4	85.9	94.0	100.0	332.3	1127.0	3.4
25/7/2004	3	17:00:00	527	51.5	44.8	85.2	92.9	98.5	312.2	1094.3	3.5
6/8/2004	3	5:00:00	485	51.4	44.6	84.4	91.4	97.0	287.3	1110.7	3.9
6/8/2004	3	6:00:00	445	50.7	44.6	83.9	90.0	95.8	263.6	996.3	3.8
6/8/2004	3	7:00:00	475	51.0	44.5	84.4	91.1	96.3	281.4	1061.7	3.8
6/8/2004	3	8:00:00	481	51.0	44.5	84.5	91.2	96.0	284.9	1061.7	3.7
6/8/2004	3	9:00:00	517	51.8	44.7	85.3	92.8	99.1	306.3	1159.7	3.8
6/8/2004	3	10:00:00	582	52.8	44.8	86.4	94.8	102.4	344.8	1306.7	3.8
6/8/2004	3	11:00:00	598	52.3	44.7	85.1	93.8	101.2	354.2	1241.3	3.5
6/8/2004	3	12:00:00	576	52.2	44.7	84.0	92.7	100.0	341.2	1225.0	3.6
6/8/2004	3	13:00:00	596	52.5	44.8	84.3	93.1	100.6	353.0	1257.7	3.6
6/8/2004	3	14:00:00	594	52.7	45.0	85.2	93.9	101.5	351.9	1257.7	3.6
6/8/2004	3	15:00:00	592	52.5	44.8	85.1	93.9	101.5	350.7	1257.7	3.6
6/8/2004	3	16:00:00	602	53.3	45.7	86.2	94.9	102.7	356.6	1241.3	3.5
6/8/2004	3	17:00:00	600	53.1	45.5	86.3	95.0	102.7	355.4	1241.3	3.5
7/8/2004	3	15:00:00	600	53.2	45.6	85.9	94.7	102.4	355.4	1241.3	3.5
7/8/2004	3	16:00:00	604	53.6	46.0	86.3	95.0	103.0	357.8	1241.3	3.5
7/8/2004	3	17:00:00	604	53.2	45.6	86.2	94.1	102.7	357.8	1241.3	3.5
7/8/2004	3	18:00:00	602	52.4	44.8	85.7	94.3	101.8	356.6	1241.3	3.5
7/8/2004	3	19:00:00	606	52.9	45.3	85.7	94.4	102.1	359.0	1241.3	3.5
7/8/2004	3	20:00:00	604	52.8	45.1	85.6	94.3	101.8	357.8	1257.7	3.5
7/8/2004	3	21:00:00	594	52.6	44.9	85.5	94.1	101.8	351.9	1257.7	3.6
7/8/2004	3	22:00:00	600	52.4	44.7	85.5	94.1	101.5	355.4	1257.7	3.5
7/8/2004	3	23:00:00	519	51.7	44.4	84.8	92.3	98.5	307.4	1192.3	3.9
8/8/2004	3	0:00:00	463	52.2	44.3	84.8	91.2	96.0	274.3	1290.3	4.7
8/8/2004	3	9:00:00	539	52.3	44.8	85.0	92.9	99.1	319.3	1225.0	3.8

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
8/8/2004	3	10:00:00	594	52.7	45.3	87.1	95.5	103.0	351.9	1208.7	3.4
8/8/2004	3	11:00:00	594	52.7	45.3	87.1	95.5	103.0	351.9	1208.7	3.4
8/8/2004	3	12:00:00	596	52.7	45.1	85.4	94.1	101.8	353.0	1241.3	3.5
8/8/2004	3	13:00:00	606	53.5	46.0	86.7	95.4	103.0	359.0	1225.0	3.4
8/8/2004	3	14:00:00	594	52.1	44.8	86.8	95.1	102.4	351.9	1192.3	3.4
8/8/2004	3	15:00:00	574	51.5	44.5	86.7	94.8	101.8	340.0	1143.3	3.4
8/8/2004	3	16:00:00	578	51.6	44.5	86.6	94.7	101.8	342.4	1159.7	3.4
8/8/2004	3	17:00:00	561	51.3	44.3	85.8	93.9	100.9	332.3	1143.3	3.4
8/8/2004	3	18:00:00	537	51.0	44.4	85.3	93.0	99.7	318.1	1078.0	3.4
8/8/2004	3	19:00:00	596	52.6	45.1	86.3	94.8	102.4	353.0	1225.0	3.5
8/8/2004	3	20:00:00	596	52.7	45.2	86.0	94.6	102.1	353.0	1225.0	3.5
22/7/2004	1	1:00:00	389	52.4	44.4	86.5	93.3	95.7	230.4	1306.7	5.7
22/7/2004	1	2:00:00	391	52.2	44.8	89.2	95.9	98.2	231.6	1208.7	5.2
22/7/2004	1	3:00:00	395	52.1	44.7	89.2	95.6	98.1	234.0	1208.7	5.2
22/7/2004	1	4:00:00	397	51.8	44.6	89.3	96.4	98.5	235.2	1176.0	5.0
22/7/2004	1	5:00:00	402	51.9	44.4	89.7	96.4	98.7	238.1	1225.0	5.1
22/7/2004	1	6:00:00	410	50.9	44.6	89.2	96.4	98.8	242.9	1029.0	4.2
22/7/2004	1	7:00:00	422	51.3	44.8	88.9	96.3	99.1	250.0	1061.7	4.2
22/7/2004	1	8:00:00	420	51.3	44.3	86.5	94.0	97.0	248.8	1143.3	4.6
22/7/2004	1	9:00:00	487	52.7	44.9	87.1	95.8	99.4	288.5	1274.0	4.4
22/7/2004	1	10:00:00	563	53.1	45.3	87.8	97.4	101.6	333.5	1274.0	3.8
22/7/2004	1	11:00:00	575	52.8	44.9	86.6	96.2	100.3	340.6	1290.3	3.8
22/7/2004	1	12:00:00	585	53.3	45.5	86.3	96.0	100.0	346.5	1274.0	3.7
22/7/2004	1	13:00:00	571	53.7	46.1	86.4	96.0	100.3	338.2	1241.3	3.7
22/7/2004	1	14:00:00	564	53.5	45.9	86.1	95.7	99.8	334.1	1241.3	3.7
22/7/2004	1	15:00:00	561	53.4	45.7	85.9	95.5	99.4	332.3	1257.7	3.8
22/7/2004	1	16:00:00	585	53.7	45.9	86.1	95.8	100.0	346.5	1274.0	3.7
22/7/2004	1	17:00:00	585	53.6	45.8	86.3	96.0	100.0	346.5	1274.0	3.7
22/7/2004	1	18:00:00	582	53.4	45.6	86.0	95.8	100.0	344.8	1274.0	3.7
22/7/2004	1	19:00:00	577	53.7	45.3	85.7	95.4	99.4	341.8	1372.0	4.0
23/7/2004	1	1:00:00	395	52.6	44.5	86.0	93.0	96.8	234.0	1323.0	5.7
23/7/2004	1	2:00:00	410	52.2	44.4	89.5	96.7	99.1	242.9	1274.0	5.2

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
23/7/2004	1	3:00:00	408	52.0	44.4	89.5	96.7	99.9	241.7	1241.3	5.1
23/7/2004	1	4:00:00	402	51.8	44.4	89.4	96.6	99.5	238.1	1208.7	5.1
23/7/2004	1	5:00:00	400	51.6	44.4	89.3	96.6	99.5	236.9	1176.0	5.0
23/7/2004	1	6:00:00	408	50.6	44.3	88.7	96.0	98.5	241.7	1029.0	4.3
23/7/2004	1	7:00:00	426	51.4	44.9	89.1	96.7	99.7	252.3	1061.7	4.2
23/7/2004	1	8:00:00	426	51.4	44.9	89.1	96.7	99.7	252.3	1061.7	4.2
23/7/2004	1	9:00:00	481	52.6	44.8	86.4	95.2	98.8	284.9	1274.0	4.5
23/7/2004	1	10:00:00	544	53.2	45.0	87.0	96.6	100.6	322.2	1339.3	4.2
23/7/2004	1	11:00:00	579	53.1	45.3	85.8	95.5	99.7	343.0	1274.0	3.7
23/7/2004	1	12:00:00	579	53.1	45.3	85.8	95.5	99.7	343.0	1274.0	3.7
23/7/2004	1	13:00:00	571	53.6	46.0	86.1	95.7	100.0	338.2	1241.3	3.7
23/7/2004	1	14:00:00	581	54.1	46.4	86.2	95.8	100.0	344.2	1257.7	3.7
23/7/2004	1	15:00:00	587	54.0	46.3	85.8	95.5	99.7	347.7	1257.7	3.6
23/7/2004	1	16:00:00	571	53.9	46.2	85.5	95.1	99.4	338.2	1257.7	3.7
23/7/2004	1	17:00:00	577	53.6	45.9	85.5	95.1	99.4	341.8	1257.7	3.7
24/7/2004	1	1:00:00	395	52.5	44.5	85.2	92.3	96.1	234.0	1306.7	5.6
24/7/2004	1	2:00:00	397	52.4	44.5	85.1	92.2	96.0	235.2	1290.3	5.5
24/7/2004	1	3:00:00	375	52	44.5	84.6	91.3	94.4	222.1	1225.0	5.5
24/7/2004	1	4:00:00	375	52	44.5	84.6	91.3	94.4	222.1	1225.0	5.5
24/7/2004	1	5:00:00	391	50.6	44.3	84.7	91.8	95.4	231.6	1029.0	4.4
24/7/2004	1	6:00:00	391	50.6	44.3	84.7	91.8	95.4	231.6	1029.0	4.4
24/7/2004	1	7:00:00	406	51.3	44.7	84.4	91.8	95.7	240.5	1078.0	4.5
24/7/2004	1	8:00:00	402	51.1	44.5	84.8	92.3	96.1	238.1	1078.0	4.5
24/7/2004	1	9:00:00	485	52.6	44.8	86.2	95.0	98.8	287.3	1274.0	4.4
24/7/2004	1	10:00:00	502	52.5	44.7	86.7	95.7	99.4	297.4	1274.0	4.3
24/7/2004	1	11:00:00	583	52.6	44.9	85.3	95.0	99.1	345.3	1257.7	3.6
24/7/2004	1	12:00:00	585	53.2	45.4	85.2	94.9	99.1	346.5	1274.0	3.7
24/7/2004	1	13:00:00	569	53.1	45.4	84.5	94.2	98.2	337.1	1257.7	3.7
24/7/2004	1	14:00:00	569	53.2	45.6	84.6	94.2	98.2	337.1	1241.3	3.7
24/7/2004	1	15:00:00	571	53.4	45.7	85.2	94.8	98.8	338.2	1257.7	3.7
24/7/2004	1	16:00:00	581	53.1	45.3	84.5	94.3	98.5	344.2	1274.0	3.7
24/7/2004	1	17:00:00	585	53.1	45.3	85.2	94.9	99.1	346.5	1274.0	3.7

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
25/7/2004	1	1:00:00	387	52.6	44.7	85.7	92.6	96.1	229.2	1290.3	5.6
25/7/2004	1	2:00:00	370	52.0	44.4	84.9	91.5	94.4	219.2	1241.3	5.7
25/7/2004	1	3:00:00	371	51.9	44.4	84.7	91.3	94.4	219.8	1225.0	5.6
25/7/2004	1	4:00:00	367	51.8	44.4	84.6	91.2	94.4	217.4	1208.7	5.6
25/7/2004	1	5:00:00	418	50.7	44.4	88.6	96.0	98.8	247.6	1029.0	4.2
25/7/2004	1	6:00:00	418	50.7	44.4	88.6	96.0	98.8	247.6	1029.0	4.2
25/7/2004	1	7:00:00	393	51.2	44.8	84.6	91.7	95.1	232.8	1045.3	4.5
25/7/2004	1	8:00:00	399	51.3	44.7	84.7	91.8	95.2	236.4	1078.0	4.6
25/7/2004	1	9:00:00	410	51.5	44.8	84.9	92.6	96.5	242.9	1094.3	4.5
25/7/2004	1	10:00:00	555	53.0	45.2	87.1	96.9	101.3	328.8	1274.0	3.9
25/7/2004	1	11:00:00	573	52.6	44.7	85.5	95.2	99.1	339.4	1290.3	3.8
25/7/2004	1	12:00:00	579	52.9	45.1	85.2	94.9	98.1	343.0	1274.0	3.7
25/7/2004	1	13:00:00	575	53.0	45.3	85.2	94.9	99.1	340.6	1257.7	3.7
25/7/2004	1	14:00:00	571	53.9	46.2	85.8	95.6	99.7	338.2	1257.7	3.7
25/7/2004	1	15:00:00	577	53.8	46.1	85.8	95.8	99.4	341.8	1257.7	3.7
25/7/2004	1	16:00:00	524	51.7	44.4	85.7	95.0	98.8	310.4	1192.3	3.8
25/7/2004	1	17:00:00	479	51.7	44.8	85.0	93.8	97.3	283.7	1127.0	4.0
6/8/2004	1	5:00:00	412	52.0	44.9	84.3	92.2	96.5	244.1	1159.7	4.8
6/8/2004	1	6:00:00	389	51.1	44.6	83.9	91.0	94.7	230.4	1061.7	4.6
6/8/2004	1	7:00:00	406	51.3	44.5	84.3	91.9	96.1	240.5	1110.7	4.6
6/8/2004	1	8:00:00	412	51.4	44.5	84.4	92.0	96.1	244.1	1127.0	4.6
6/8/2004	1	9:00:00	444	51.9	44.4	85.2	93.6	97.3	263.0	1225.0	4.7
6/8/2004	1	10:00:00	524	53.2	44.9	86.2	95.6	100.0	310.4	1355.7	4.4
6/8/2004	1	11:00:00	570	52.7	44.7	84.9	94.7	99.4	337.6	1306.7	3.9
6/8/2004	1	12:00:00	559	52.5	44.7	84.0	93.7	98.2	331.1	1274.0	3.8
6/8/2004	1	13:00:00	559	52.8	45.0	84.1	93.8	98.2	331.1	1274.0	3.8
6/8/2004	1	14:00:00	557	53.0	45.2	85.0	94.7	99.1	329.9	1274.0	3.9
6/8/2004	1	15:00:00	553	52.8	45.0	85.0	94.5	99.1	327.6	1274.0	3.9
6/8/2004	1	16:00:00	579	53.6	45.7	86.1	96.1	100.6	343.0	1290.3	3.8
6/8/2004	1	17:00:00	579	53.4	45.6	86.1	95.8	100.3	343.0	1274.0	3.7
7/8/2004	1	15:00:00	567	53.4	45.8	86.0	95.7	100.0	335.9	1241.3	3.7
7/8/2004	1	16:00:00	587	53.8	46.0	86.3	96.1	101.0	347.7	1274.0	3.7

**Appendix  
Chiller Log Data**

**Park Lane Hotel**

	Chiller #	Time range	Current	Entering Chilled Water Temp	Leaving Chilled Water Temp	Entering Condensing Water Temp	Leaving Condensing Water Temp	Con. Ref. Temp	Power Consumption	Cooling Load	COP
DATE		TIME	CA_A	ECW	LCW	ECDW	LCDW	CRT		KW	
7/8/2004	1	17:00:00	583	53.4	45.6	86.0	95.8	100.3	345.3	1274.0	3.7
7/8/2004	1	18:00:00	579	52.7	44.9	85.6	95.4	100.0	343.0	1274.0	3.7
7/8/2004	1	19:00:00	575	53.2	45.4	85.5	95.3	99.7	340.6	1274.0	3.7
7/8/2004	1	20:00:00	557	53.0	45.3	85.4	95.0	99.4	329.9	1257.7	3.8
7/8/2004	1	21:00:00	555	52.9	45.2	85.5	95.0	99.4	328.8	1257.7	3.8
7/8/2004	1	22:00:00	557	52.7	44.9	85.3	94.9	99.4	329.9	1274.0	3.9
7/8/2004	1	23:00:00	457	52.0	44.3	84.8	93.3	97.0	270.7	1257.7	4.6
8/8/2004	1	0:00:00	395	52.6	44.3	84.8	92.0	95.7	234.0	1355.7	5.8
8/8/2004	1	9:00:00	471	52.5	44.8	84.7	93.5	97.3	279.0	1257.7	4.5
8/8/2004	1	10:00:00	567	53.0	45.1	86.8	96.6	101.3	335.9	1290.3	3.8
8/8/2004	1	11:00:00	563	53.0	45.1	86.8	96.6	101.3	333.5	1290.3	3.9
8/8/2004	1	12:00:00	579	52.9	45.0	85.3	95.1	99.7	343.0	1290.3	3.8
8/8/2004	1	13:00:00	598	53.8	45.9	86.6	96.5	101.6	354.2	1290.3	3.6
8/8/2004	1	14:00:00	575	52.4	44.8	86.7	96.4	101.0	340.6	1241.3	3.6
8/8/2004	1	15:00:00	544	51.8	44.5	86.6	95.9	100.3	322.2	1192.3	3.7
8/8/2004	1	16:00:00	542	51.9	44.5	86.6	95.8	100.0	321.1	1208.7	3.8
8/8/2004	1	17:00:00	522	51.6	44.3	85.7	94.8	99.1	309.2	1192.3	3.9
8/8/2004	1	18:00:00	487	51.3	44.3	85.2	93.9	97.9	288.5	1143.3	4.0
8/8/2004	1	19:00:00	581	52.9	45.0	86.1	95.9	100.6	344.2	1290.3	3.7
8/8/2004	1	20:00:00	577	53.0	45.2	86.0	95.8	100.3	341.8	1274.0	3.7