

**AN EVALUATION**

**OF**

**THE EFFECTS OF**

**Permafrost**

**ON A**

**CARRIER 30HS100 WATER  
Water Chiller**

**For**

**HYSAN PROPERTIES**

**CAUSEWAY BAY,**

**HONG KONG, SAR**

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## Introduction

The aim of this report is to examine the effects of a product known as PermaFrost upon the refrigeration system of the water-cooled, reciprocating Carrier 30HS100 water chiller at Hysan Properties, Hong Kong.

PermaFrost has previously been claimed to enhance the performance of refrigeration and air conditioning systems elsewhere. Literature from the Polar Oil Company (which markets the product) states that PermaFrost – a molecular technology that relies on highly activated thermal conductive compounds - will improve heat transfer on metal surfaces and increase lubricity of the refrigerant oil.

It further states: “When PermaFrost’s *Thermo-Conductive* compound is added to the compressor, it blends with the oil and moves through the system. As each molecule attaches itself to metal surfaces within the system, it displaces dirt, carbon deposits, and stagnant oils, eventually forming a thin layer. As a result, the system can move more heat for the same amount of compressor action. Energy demand and consumption can be reduced.”

## **METHODOLOGY**

The testing procedure included an analysis of the refrigeration system on two occasions:

- 1) Before the addition of PermaFrost, and
- 2) After addition of the product.

To measure the performance of the refrigeration system, a data logger was used to data log the operating conditions of the system during testing. For each test, the analyser collected the data on the following operating conditions over a 3 to 6 hour period at one minute interval:

- Power input
- Chilled water inlet & outlet temperatures
- Compressor discharge & suction temperatures
- Evaporating & condensing pressures

The cooling capacity and the coefficient of performance (COP) were calculated from the data collected. The cooling capacity calculations were based on the temperature difference between the chilled water inlet & outlet temperatures and a design flow rate of 16 litres/s. The COP calculations were based on the ratio of cooling capacity to power input.

## **TESTING**

The refrigeration system of the chiller was first tested on July 3, 200 before the product, PermaFrost was introduced into the system and then on September 4, 2004 after the treatment. On both occasions the compressor was running at full capacity.

On the first test, the average operating condensing pressure was 1584.05 kPa. On the final test, the average operating condensing pressure was 1521.85 kPa. Ideally both the values should be similar as a “yardstick” for comparison. But given the constraint of an operating plant, the average operating condensing pressure for the final test was 3.93% lower than the first test.

## **RESULTS OF TESTING**

Detailed results of the operating conditions are provided in the following charts, all found in Appendix A:

1. Pre-treatment Test (July 3, 2004)

Chart 1A: Cooling Capacity, Power Input & Coefficient of Performance

Chart 2A: Evaporator & Condenser Pressures

Chart 3A: Discharge & Suction Temperatures

Chart 4A: Chilled Water Inlet & Outlet Temperatures

2. Post-treatment Test (September 4, 2004)

Chart 1B: Cooling Capacity, Power Input & Coefficient of Performance

Chart 2B: Evaporator & Condenser Pressures

Chart 3B: Discharge & Suction Temperatures

Chart 4B: Chilled Water Inlet & Outlet Temperatures

### **Observations**

A comparison of the mean operating conditions for each of the tests are summarised in table below:

#### **Test Results : Operating Mean Values**

	Pre-treatment	Post-treatment	% change
Cooling Capacity (kW)	108.60	127.89	17.76
Power Input (kW)	14.06	13.32	- 5.26
Coefficient of Performance, COP	7.73	9.60	24.19
Discharge Temperature (°C)	95.90	70.13	-3.14
Suction Temperature (°C)	15.12	22.72	50.26
Chilled Water Inlet Temperature (°C)	14.67	16.88	15.06
Chilled Water Outlet Temperature (°C)	13.05	14.98	14.79
Chilled Water Temperature Difference (K)	1.60	1.90	17.28
Condensing Pressure (kPa)	1584.05	1521.85	-3.93
Evaporating Pressure (kPa)	321.06	313.28	-2.42

From this table, a number of observations can be made about the effects of PermaFrost on the chiller:

- Cooling capacity increased by 17.76 % in the post-treatment test. ***This indicates a significant improvement in heat transfer in the evaporator.***
- Power input decreased by 5.26 % in the post-treatment test. ***This indicates a reduction in power consumption.***
- The COP increased by 24.19 % in the post-treatment test. ***This indicates a significant improvement in the overall system performance.***
- The compressor discharge temperatures decreased by 26.87 %, ***indicating a significant increase in the lubricity of the refrigerant oil in the compressor.***
- There was a reduction of the chilled water temperature difference of 17.28 %. ***This again indicates a significant improvement in heat transfer in the evaporator.***
- There was a reduction of the condensing pressure of 3.93 % probably due to lower condenser water inlet temperature resulting from lower ambient conditions.

## CONCLUSION

The tests carried out on the chiller indicated a reduction of power input of 5 % and an overall increase in system performance of 24 % after treatment with PermaFrost. **The decrease in power input and increase in system performance will result in the compressor using less energy to achieve the same cooling effect on the chilled water as prior to treatment with Permafrost.** The decrease in energy usage by the compressor will correspond approximately to the increase in the system performance. This is achieved by a reduction of the compressor run time to produce the same cooling effect on the chiller.

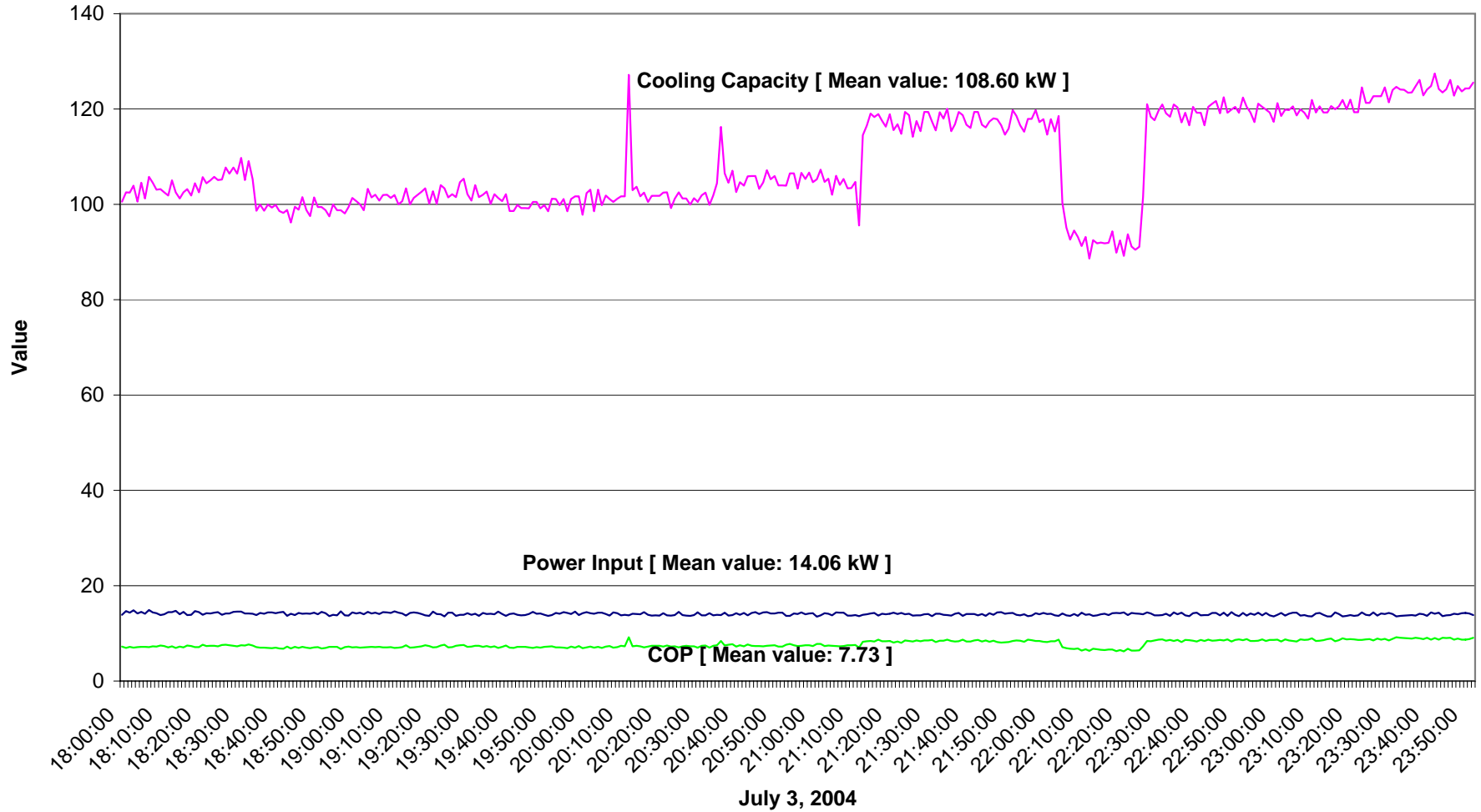
The salient results are summarised in the bar graphs in Appendix B.

# Pre Treatment Test

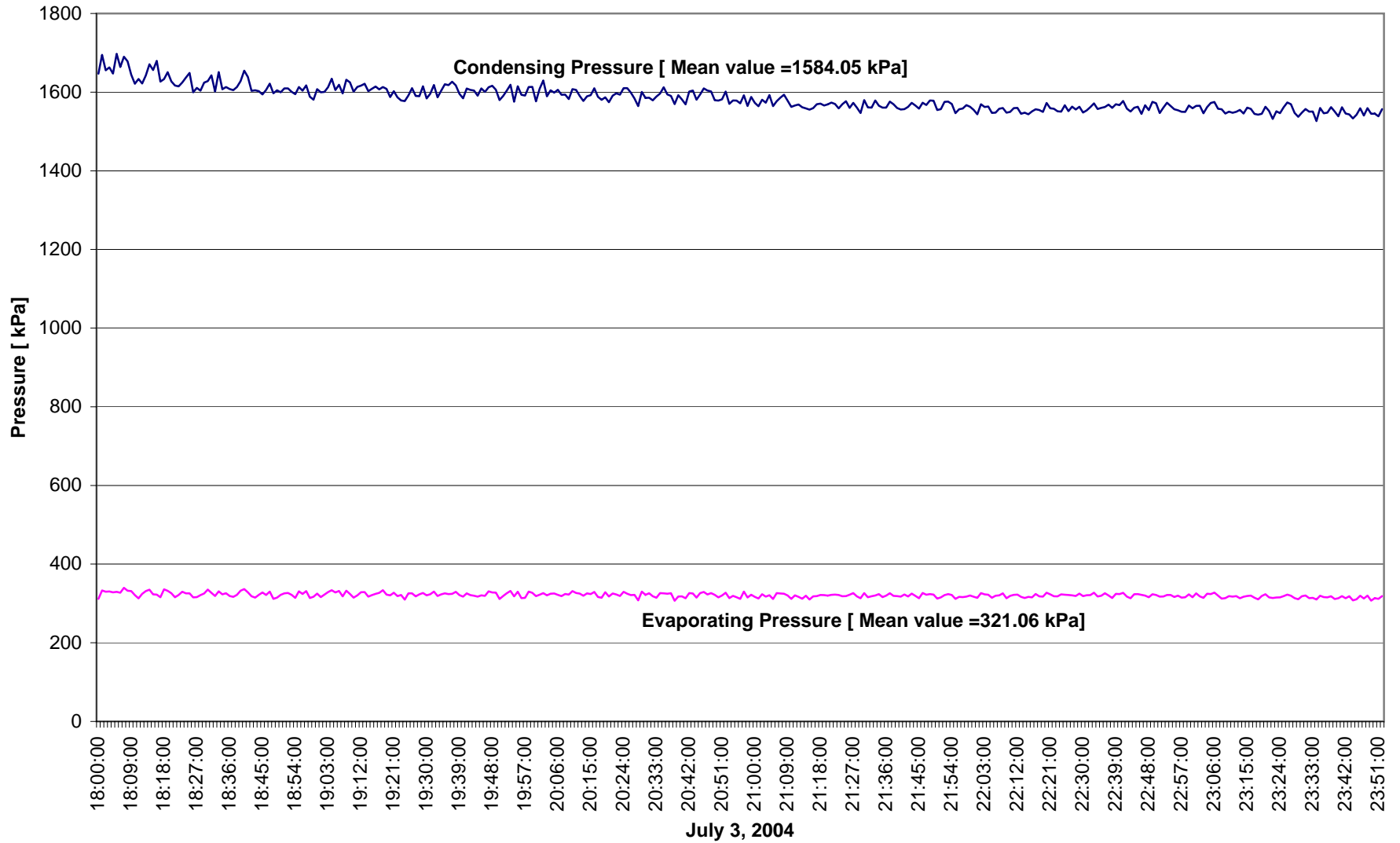
July 3, 2004

Appendix A

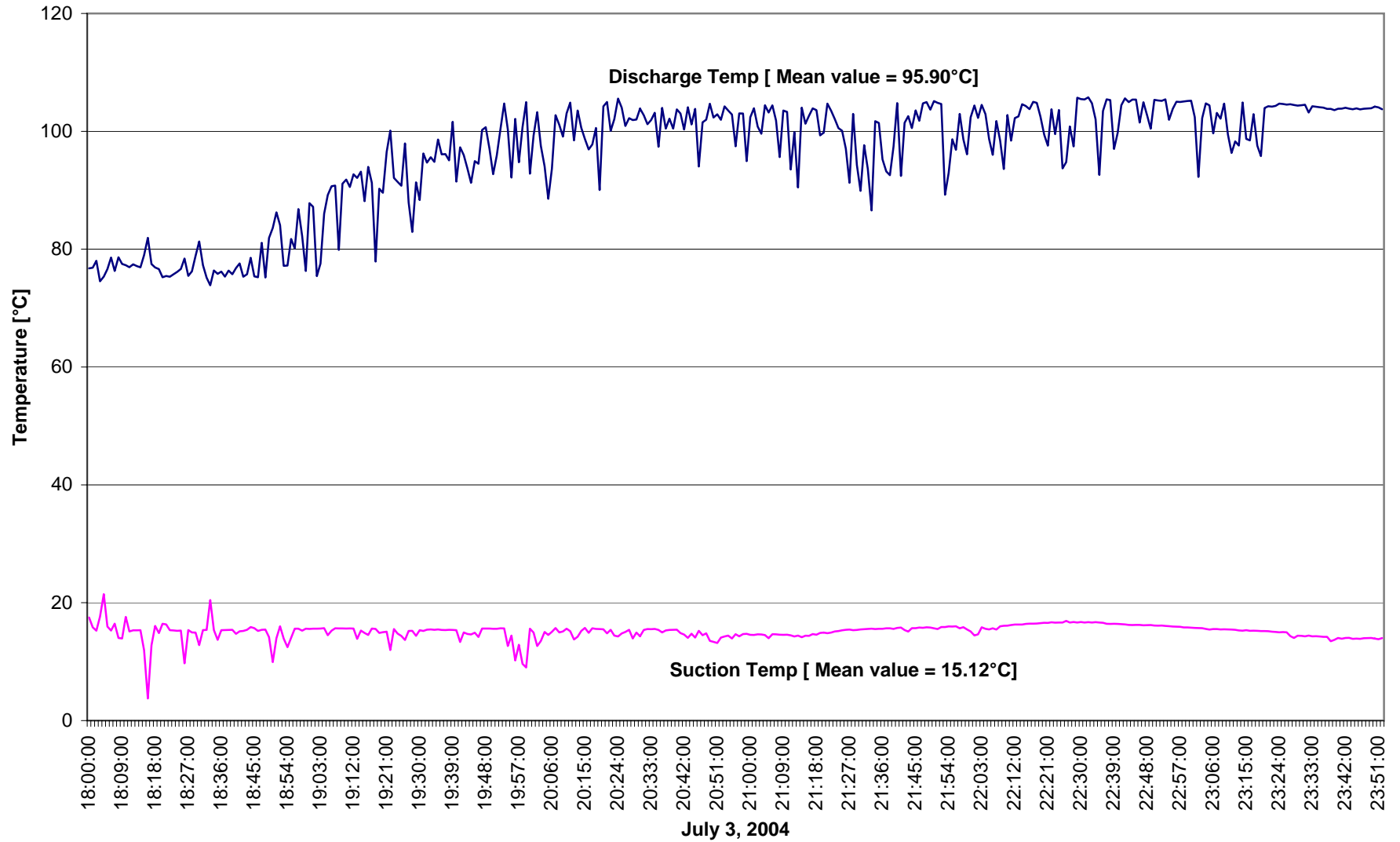
**Chart 1A - Carrier Chiller at Hysan Properties : Cooling Capacity, Power Input & COP  
[Pre-treatment]**



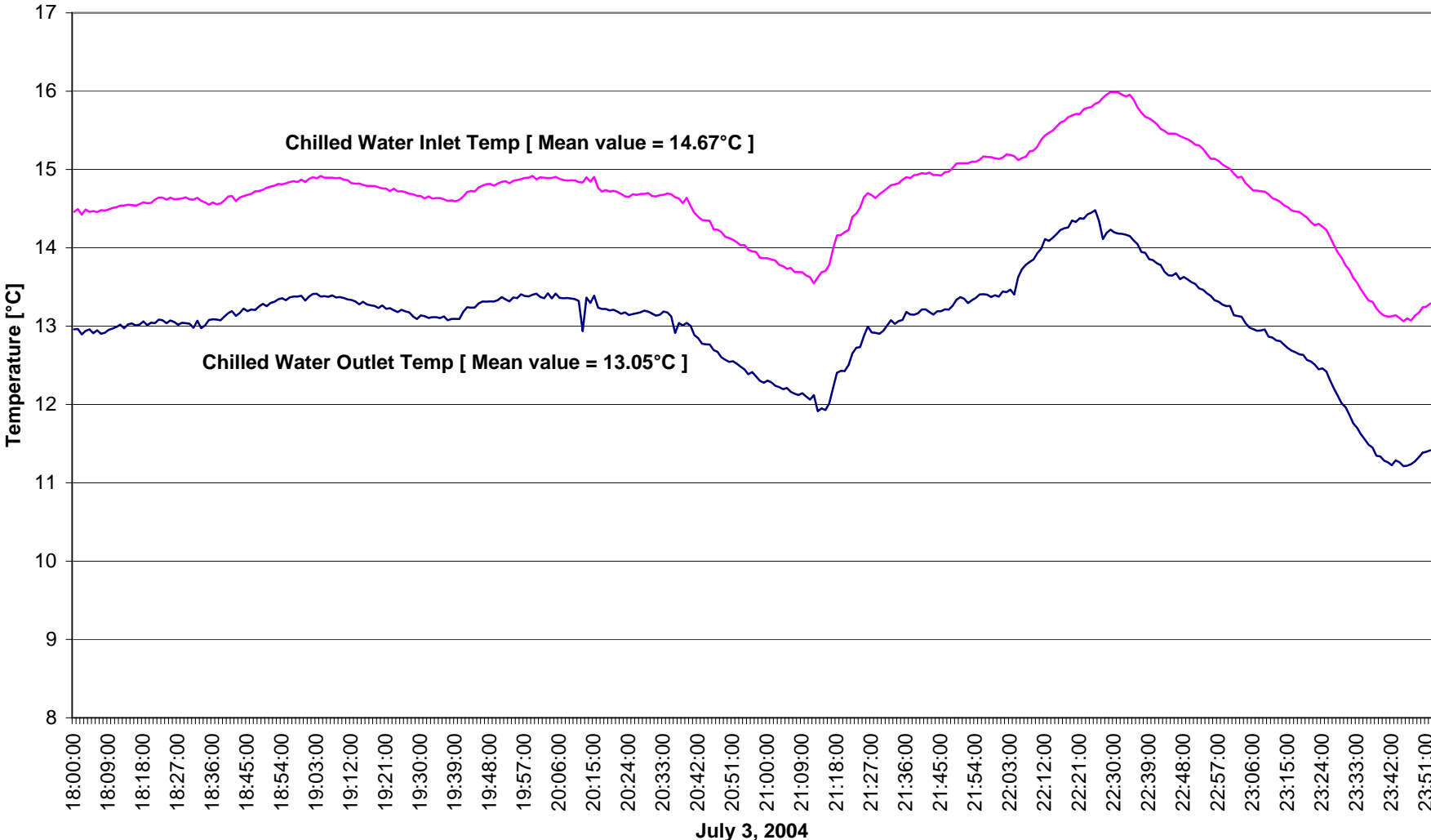
**Chart 2A - Carrier Chiller at Hysan Properties: Operating Pressures [Pre-treatment]**



**Chart 3A - Carrier Chiller at Hysan Properties: Discharge & Suction Temperatures [Pre-treatment]**



**Chart 4A - Carrier Chiller at Hysan Properties: Operating Chilled Water Temperatures [Pre-treatment]**

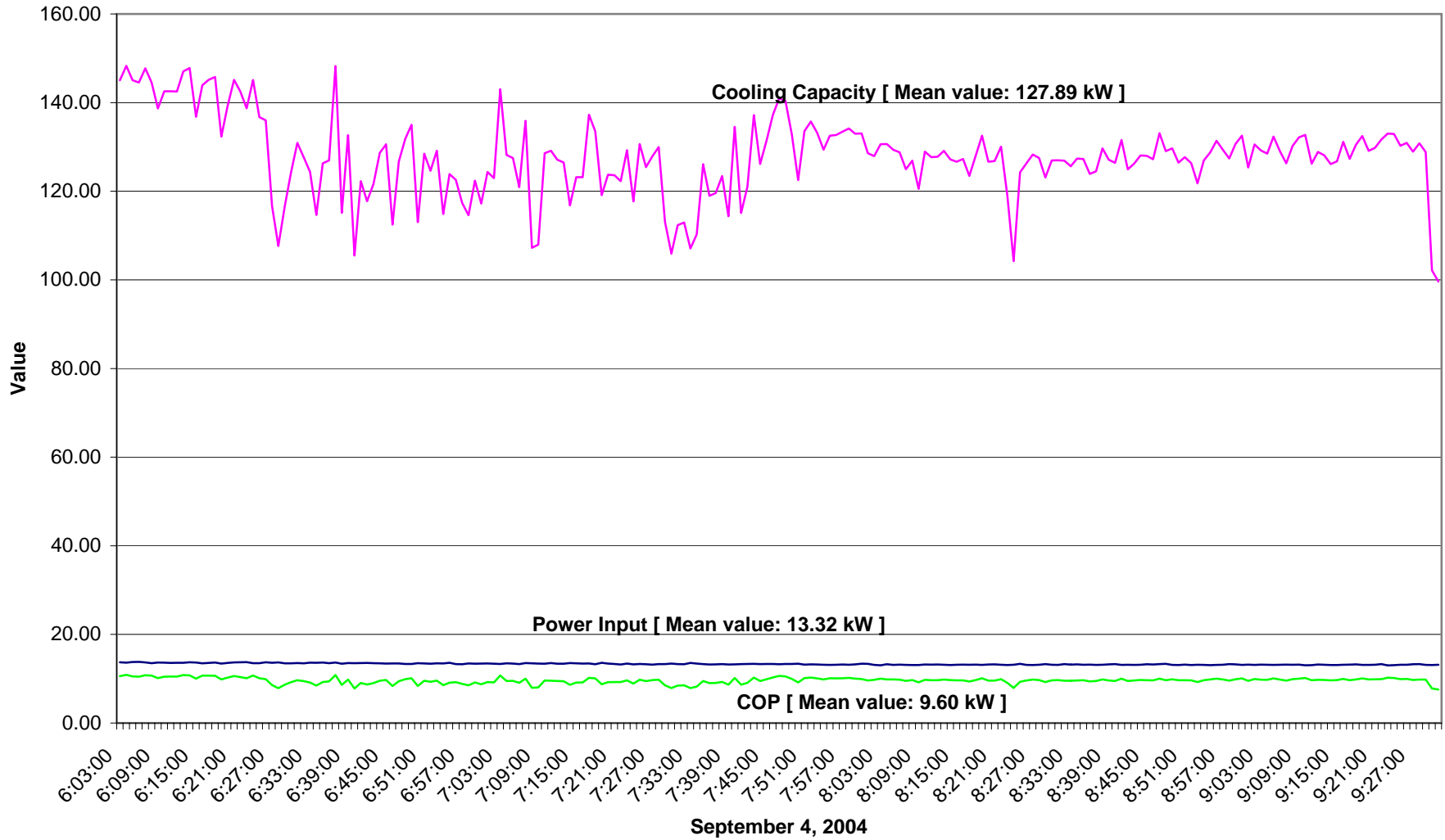


# Post Treatment Test

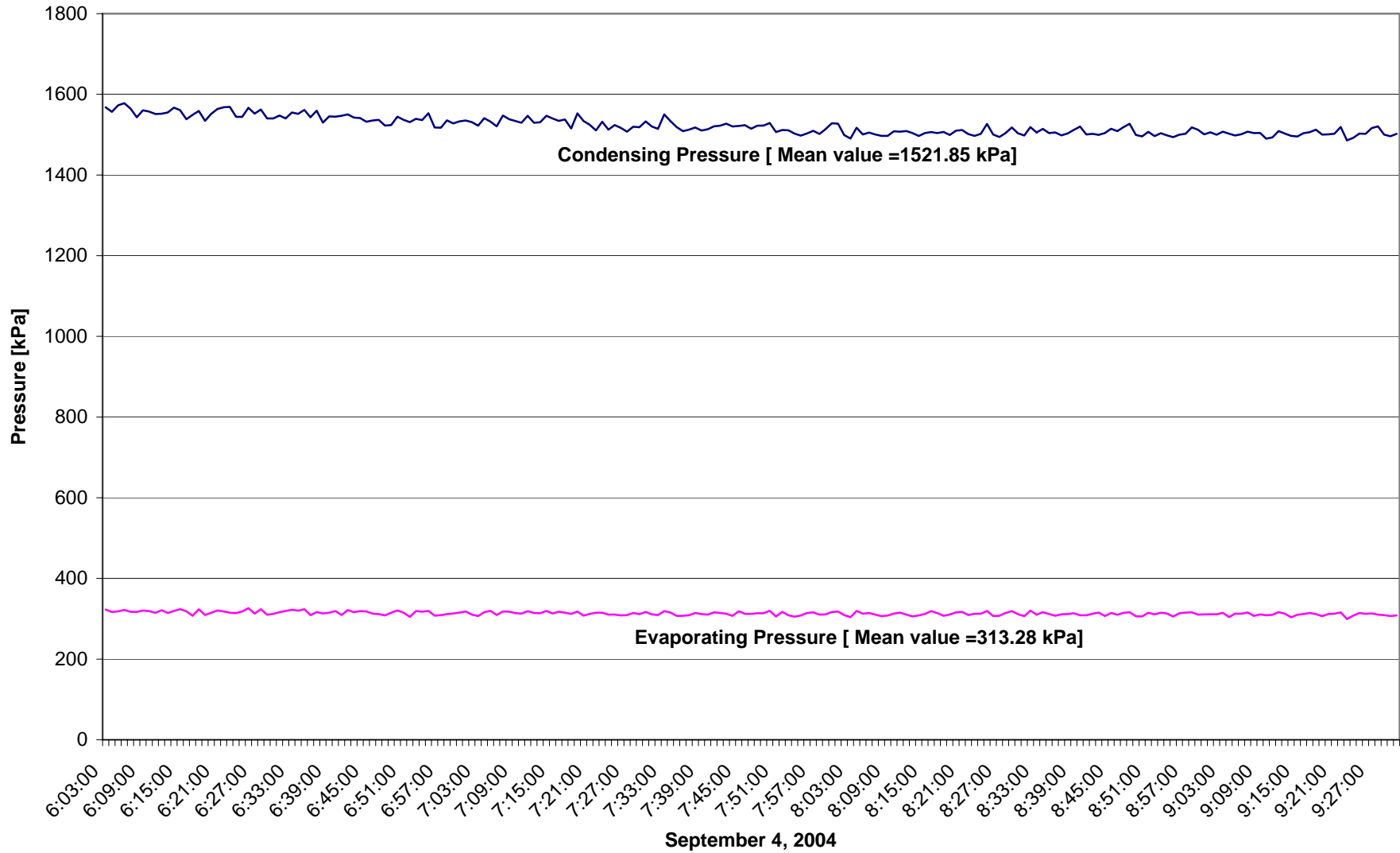
September 4, 2004

Appendix A

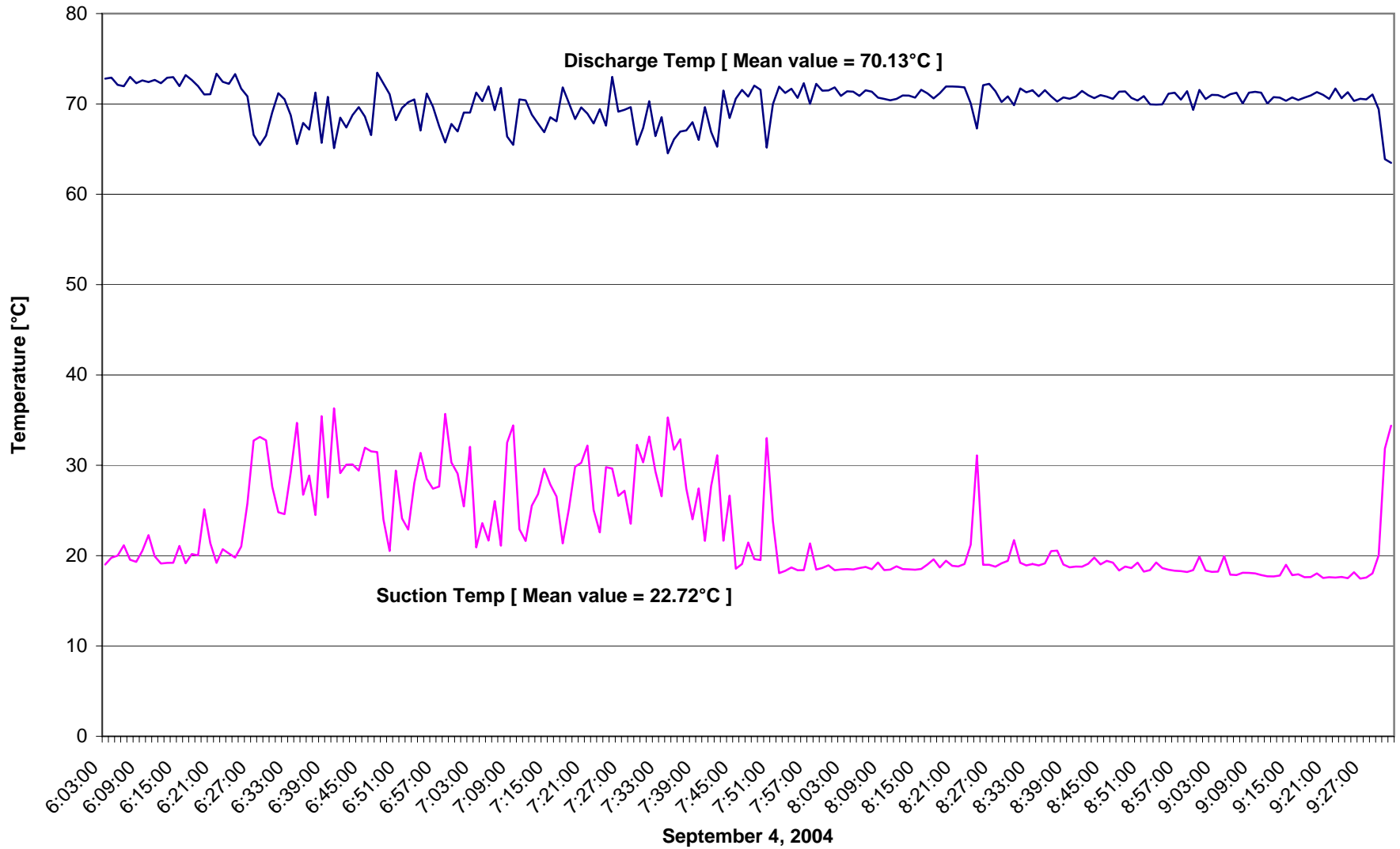
**Chart 1B- Carrier Chiller at Hysan Properties : Cooling Capacity, Power Input & COP  
[Post-treatment]**



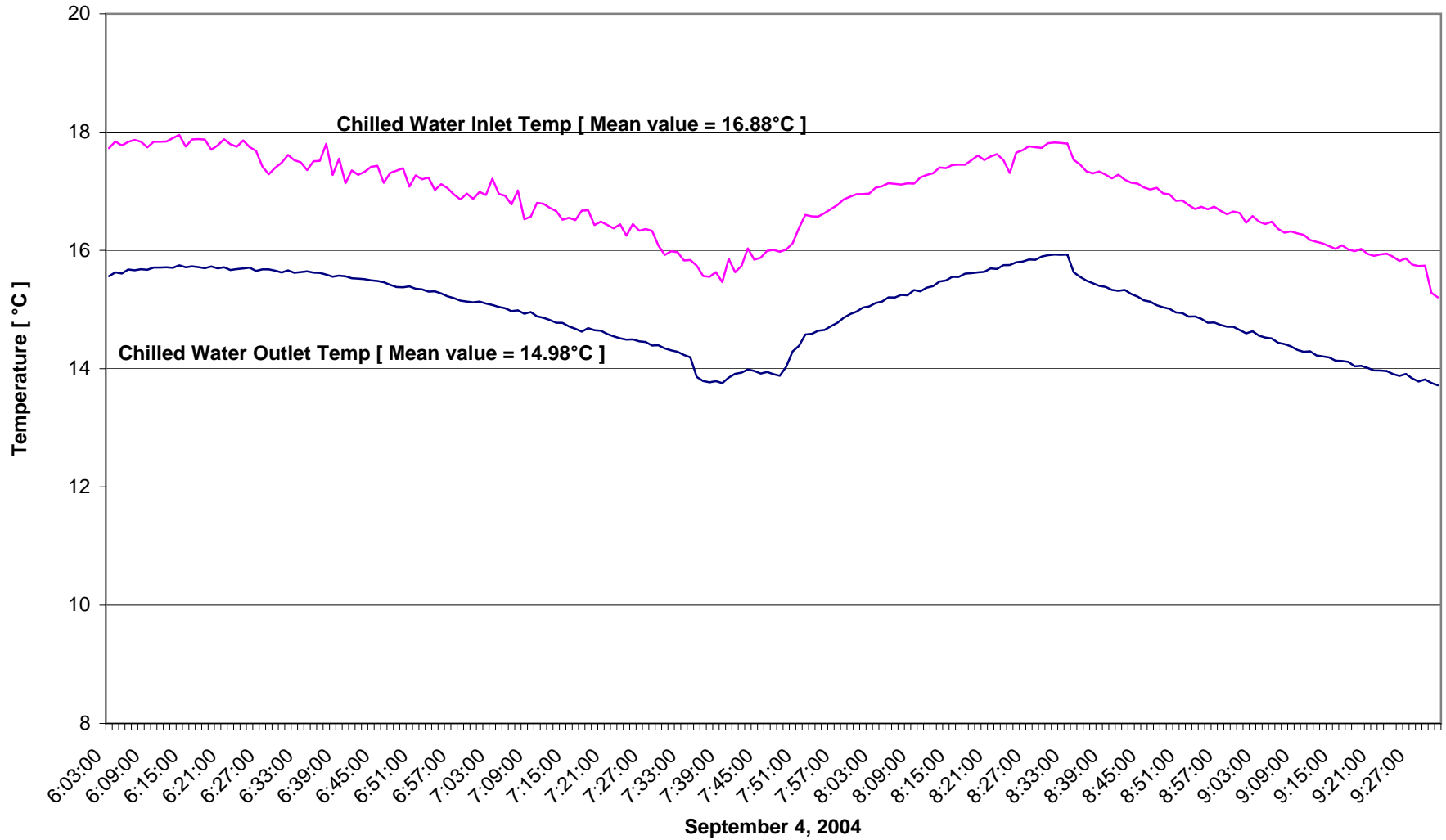
**Chart 2B - Carrier Chiller at Hysan Properties: Operating Pressures [Post-treatment]**



**Chart 3B- Carrier Chiller at Hysan Properties: Discharge & Suction Temperatures [Post-treatment]**



**Chart 4B - Carrier Chiller at Hysan Properties: Operating Chilled Water Temperatures [Post-treatment]**



# Performance Comparison

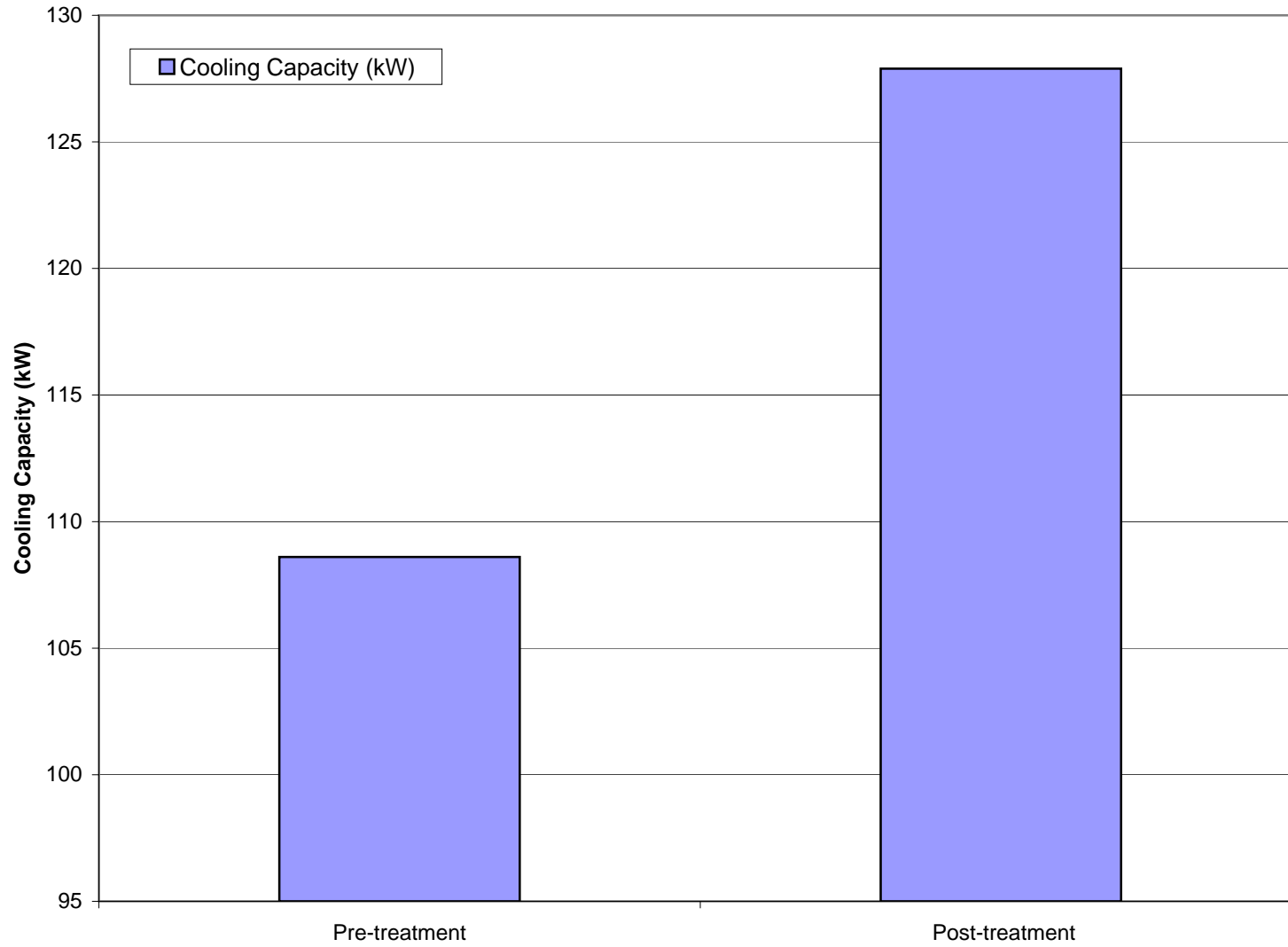
Pre: July 3, 2004

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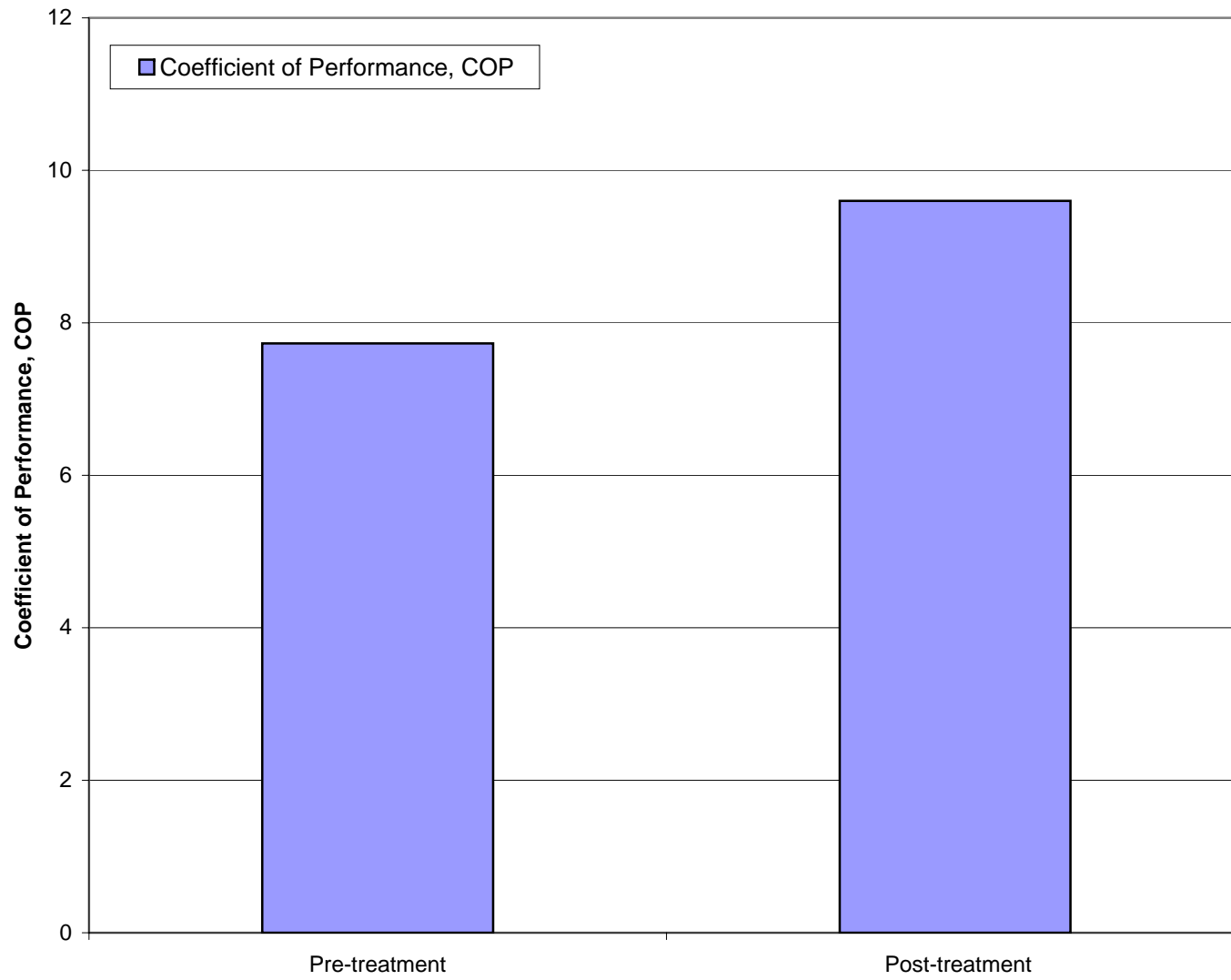
Post: July 4, 2004

Appendix B

**Comparison of Cooling Capacity resulting from treatment with PermaFrost**



**Comparison of COP resulting from treatment with PermaFrost**



Comparison of Performance of Chiller resulting from treatment with PermaFrost

