UNIVERSITY OF MARYLAND

CENTER for ENVIRONMENTAL ENERGY ENGINEERING

# Kathabar Liquid Desiccant Unit: Lessons Learned and Initial Data Collection

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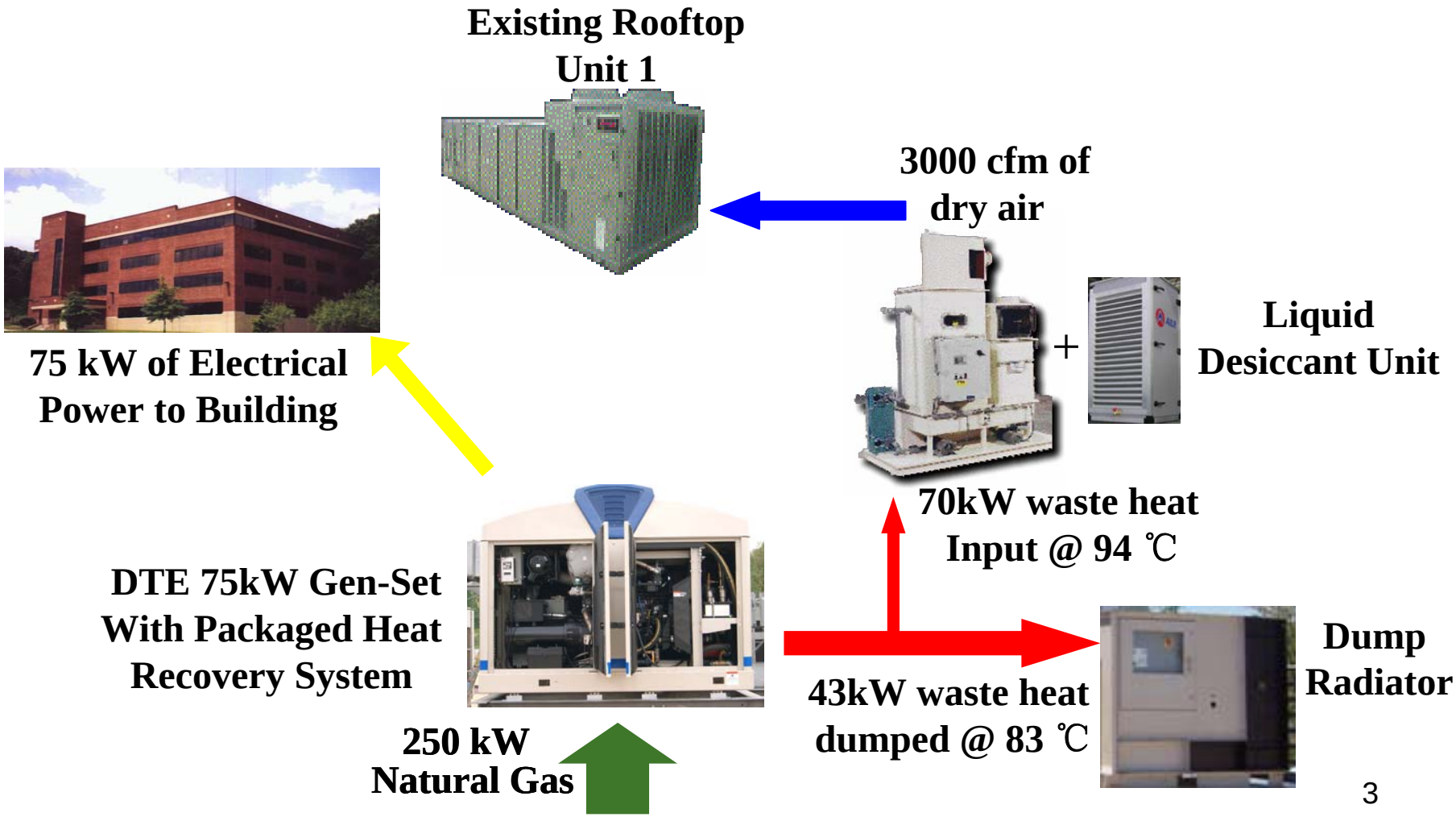
(revision)

# Overview

- CHP System 1 updates
  - Introduction
  - Maintenance effort and lessons learned
  - Experimental results of integrated engine generator – liquid desiccant system with AIL conditioner
  - Conclusions

# CHP SYSTEM 1

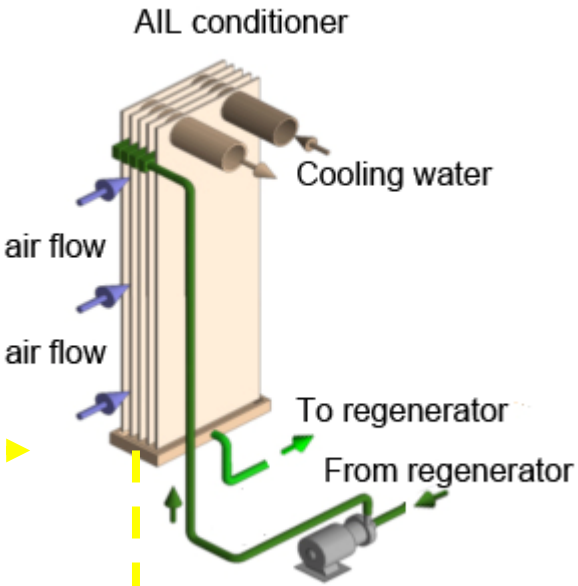
- Introduction



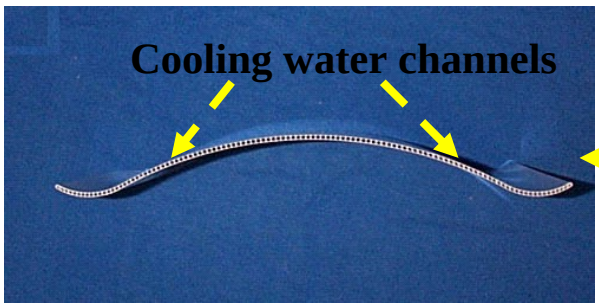
# CHP SYSTEM 1

- Introduction

Outdoor air inlet




Source: www.ailr.com



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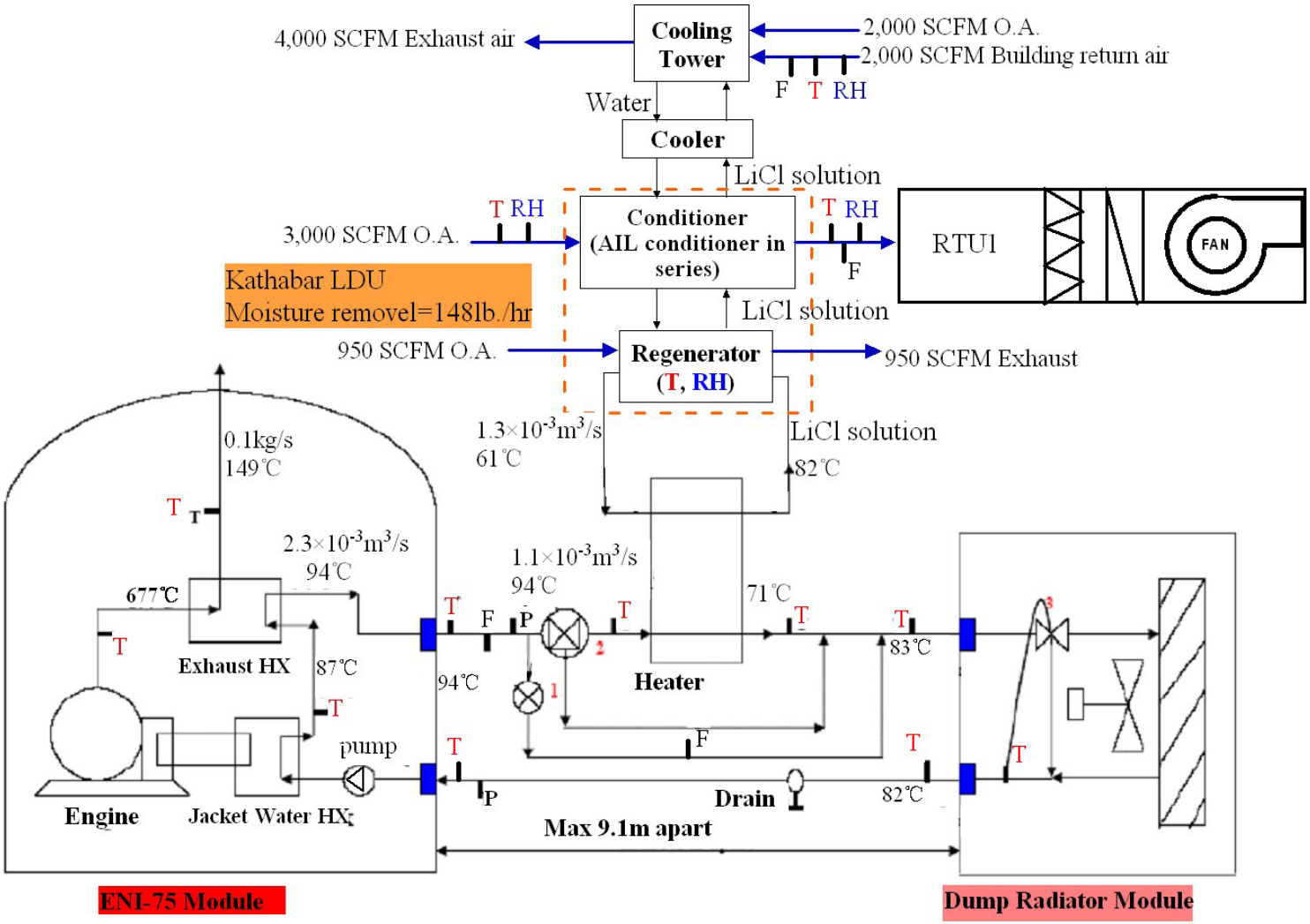


# CHP SYSTEM 1

- Maintenance effort and lessons learned
  - Engine over heating problem were solved by removing air from the glycol cooling loop and avoiding pump cavitations. The glycol cooling loop should be maintained as a closed system, however air was introduced into the system by component failures and repairs to the loop.
  - Solved the engine cranking problem by changing new battery, spark plugs and air filter. The battery is in a harsh environment and more aggressive preventive maintenance and replacement should be scheduled. Oil leakage into the combustion chamber resulted in spark plug fouling.
  - Repaired broken PVC pipes for liquid desiccant unit (LDU). Metal parts (valves) should be not be installed in the PVC pipe loop as they are heavy and cause sagging of the PVC pipes. Low spots in the PVC piping collect fluids and cause freeze damage. Mechanical support for PVC pipes should be improved.

# CHP SYSTEM 1

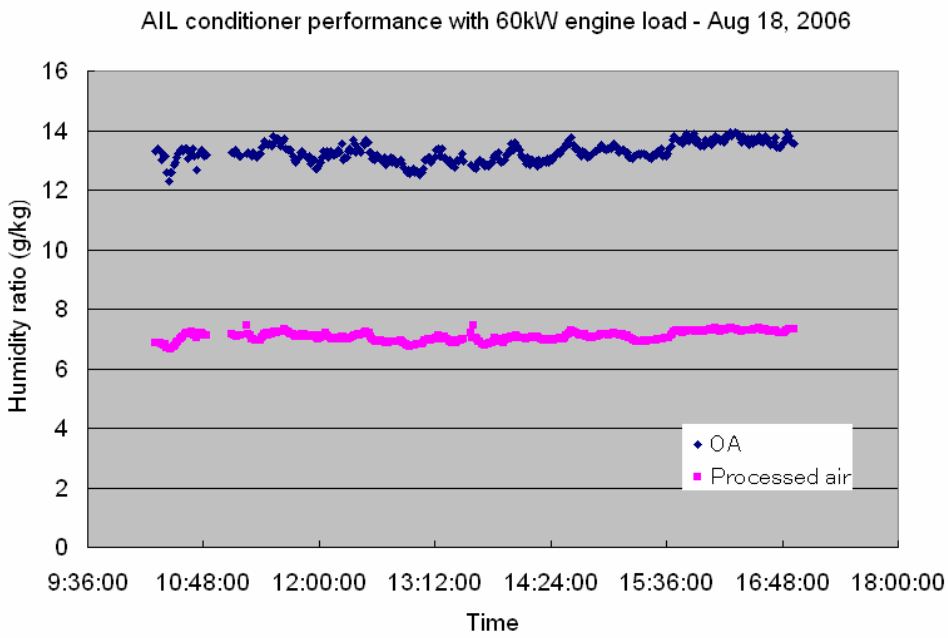
- Maintenance effort and lessons learned (cont)
  - Because of LiCl solution foaming in July, overflow and carry out happened to AIL conditioner in July. Operation of the system with the Kathabar conditioner also caused foaming problems, and it was concluded that the problem was caused by Sox emissions that were entrained in the airflow and affected the desiccant solution. The low PH desiccant solution may also damage conditioner plate surfaces, which may cause desiccant carry out. The University should seek to identify sources of SOx. Drain old LiCl solution out of LDU and run washing cycle for about 30 times. Recharged new LiCl solution in August. LDU system should be isolated effectively from engine exhaust air. The temperature difference between MT engine control module (ECM) and load control module (LCM) caused frequent MT shutting off. Solved the problem by changing a new ECM board, a new fan inverter board and a new fan. The temperature problem also causes other system faults.
  - A comprehensive maintenance program is strongly recommended if operating price certainty and high availability are important.

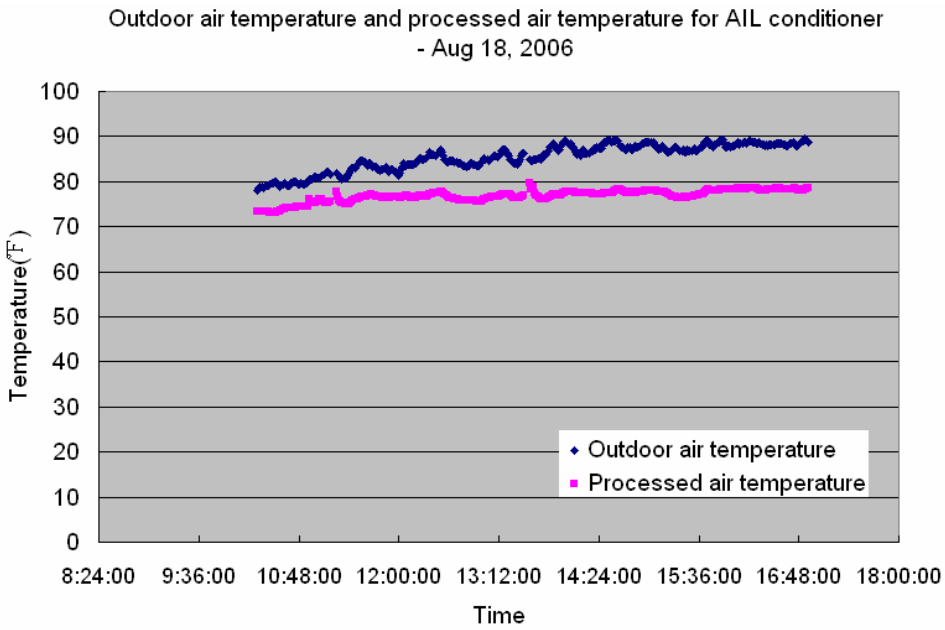
# CHP SYSTEM 1

- We can draw several conclusions about the system:
  - LDU system COP based on electricity power consumption is about 3.5. The parasitic electrical power includes the power to run solution pumps, air supply fans as well as the associated cooling tower and controls. Since the desiccant flow rate for AIL conditioner is much less than the original Kathabar conditioner (1.7gpm comparing with 20 gpm), it has great potential in improving the system COP based on electricity power.
  - LDU system COP based on waste heat input is about 0.5.
  - Under similar outdoor air conditions, AIL conditioner has comparable performance with the original Kathabar conditioner.
  - Outdoor air humidity ratio has considerable effect on LDU system performance. With 75kW engine load, when humidity ratio increases 25%, dehumidification level increases 30% and total cooling capacity increases 12%.
  - The effect of outdoor air temperature also could not be ignored. With 50kW engine load, when humidity ratio decreases 4% and temperature increases 7.6 ℉, dehumidification level increases 12% and total cooling capacity increases 40%.

# CHP SYSTEM 1

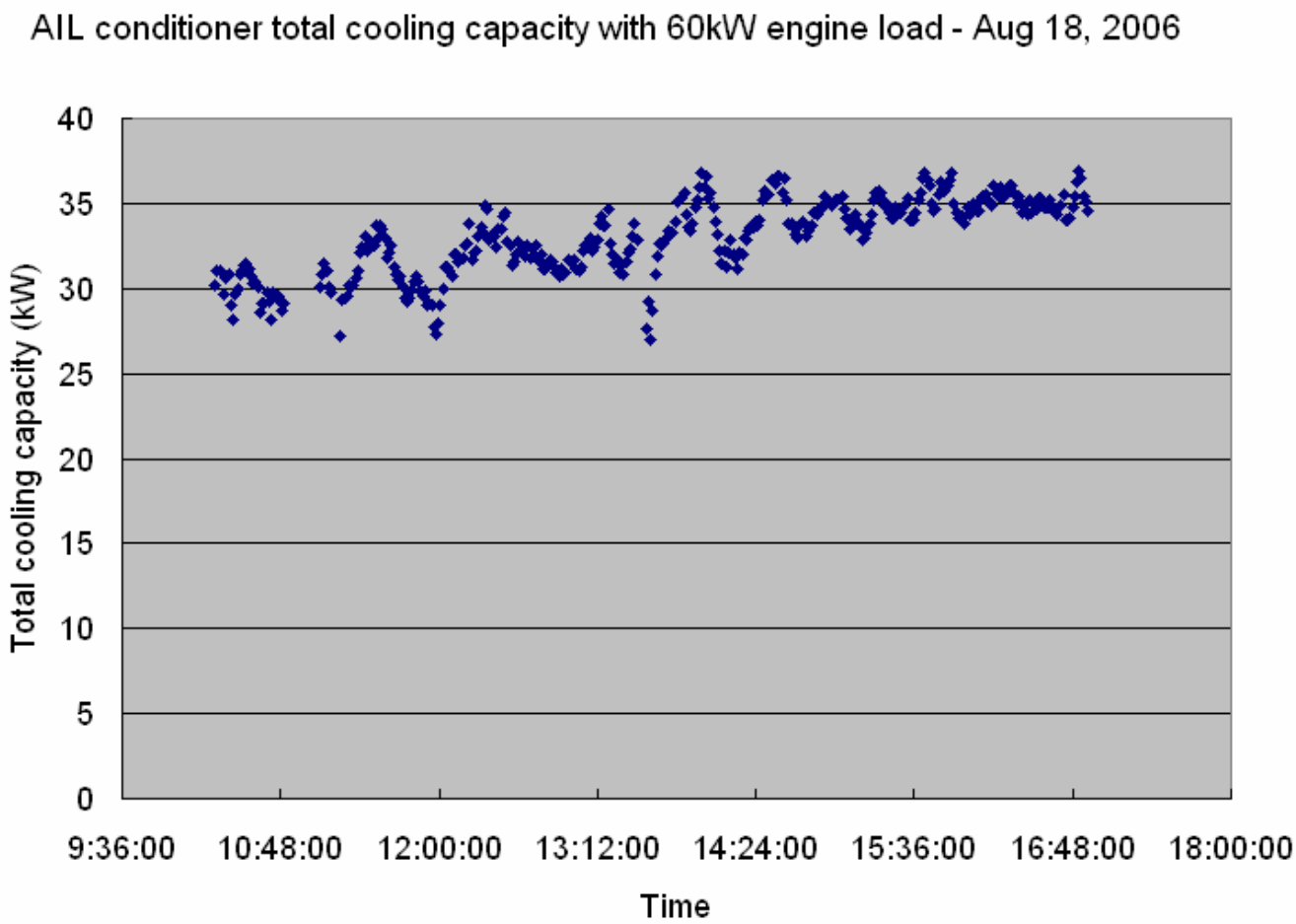
- Experimental results of integrated engine generator – liquid desiccant system with AIL conditioner
  - *System performance data on a typical summer day. (Aug 18, 2006, outdoor air condition: 85.6 ℉,50.5%, 13.3g/kg)*



# CHP SYSTEM 1

– *System performance data on a typical summer day. (Aug 18, 2006, 60kW engine load, outdoor air condition: 85.6 ℉,50.5%, 13.3g/kg)*



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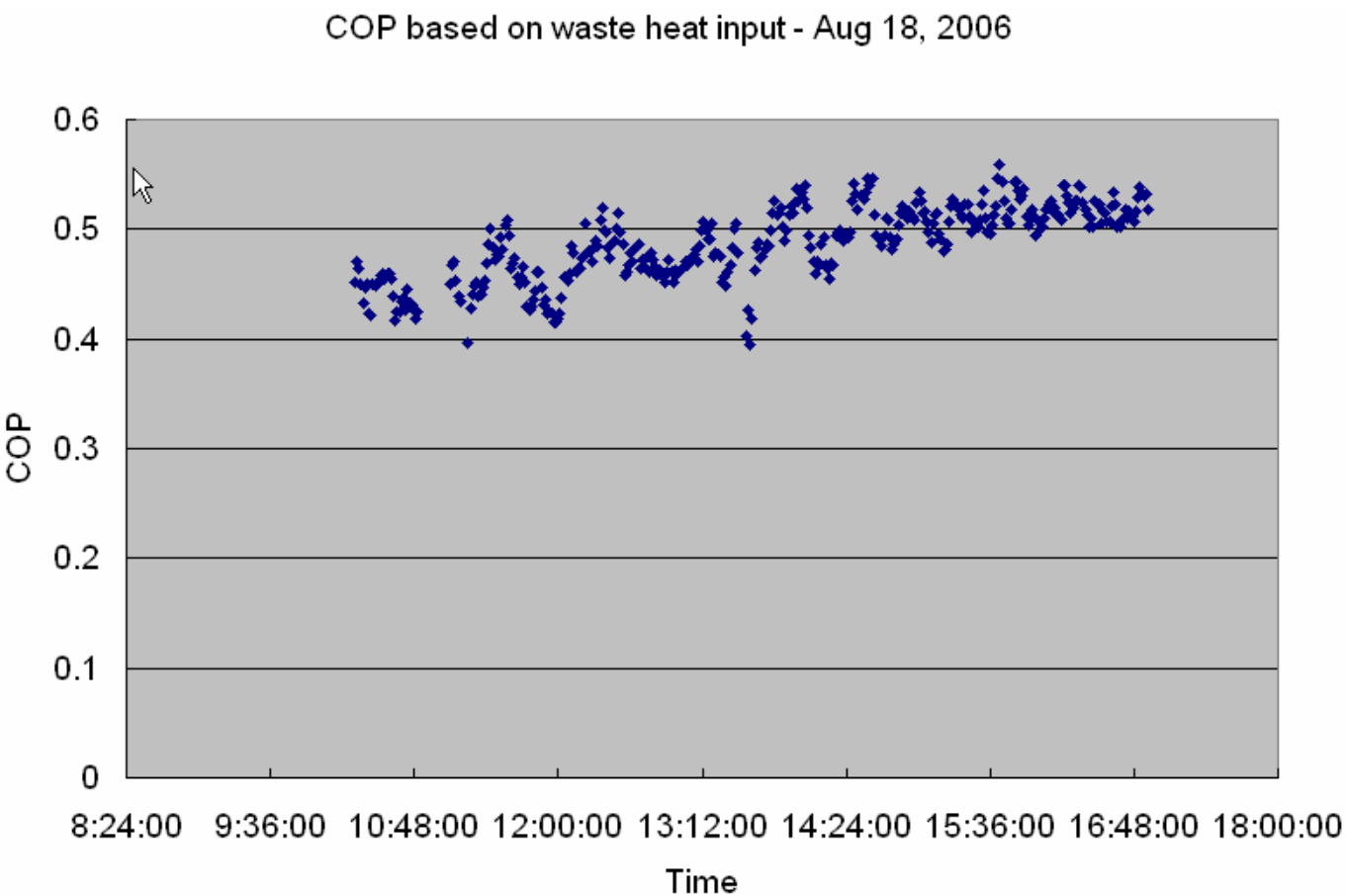


$$COP_{total,wh} = \frac{CoolCap_{total}}{WasteHeatInput}$$

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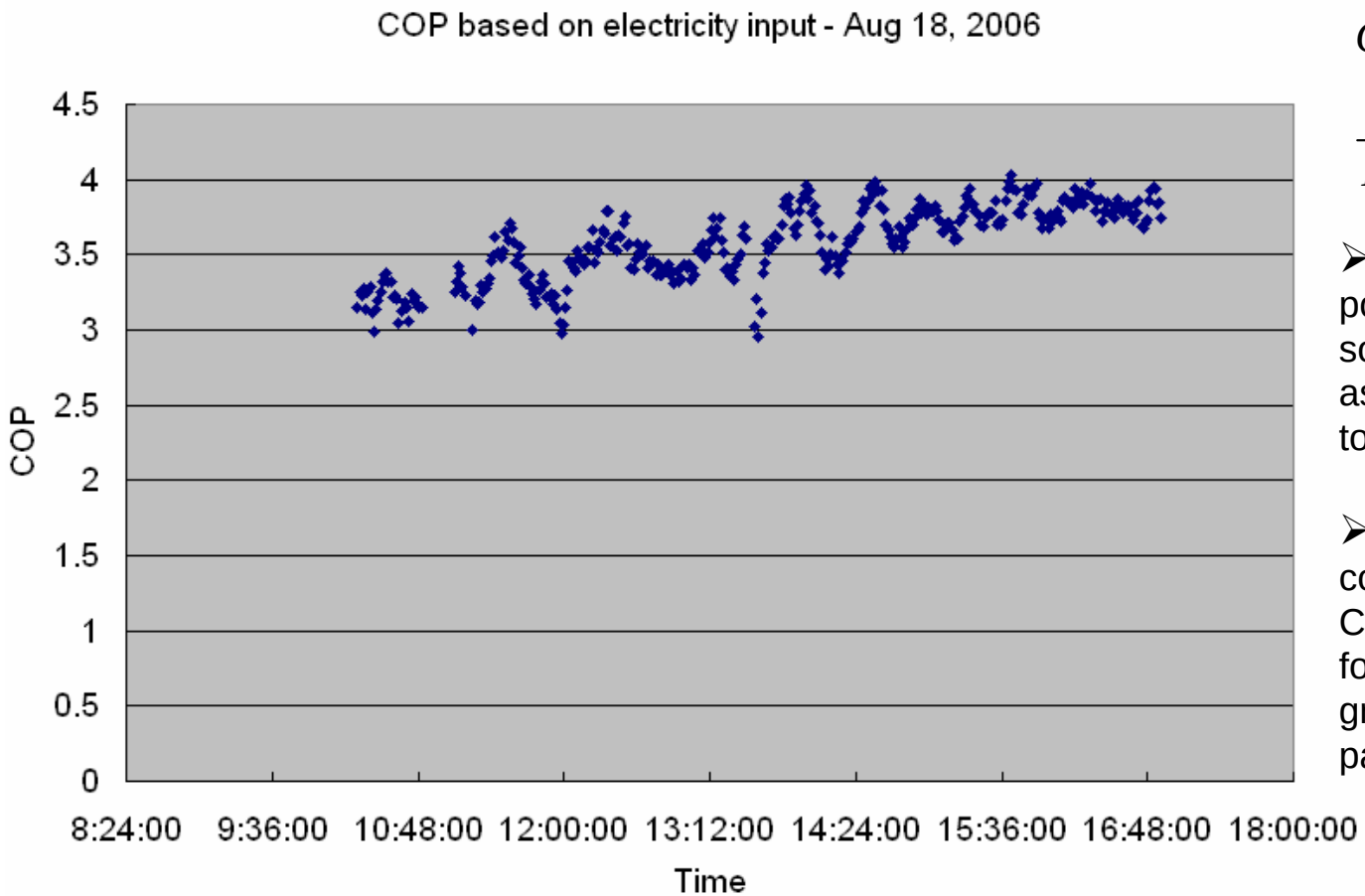


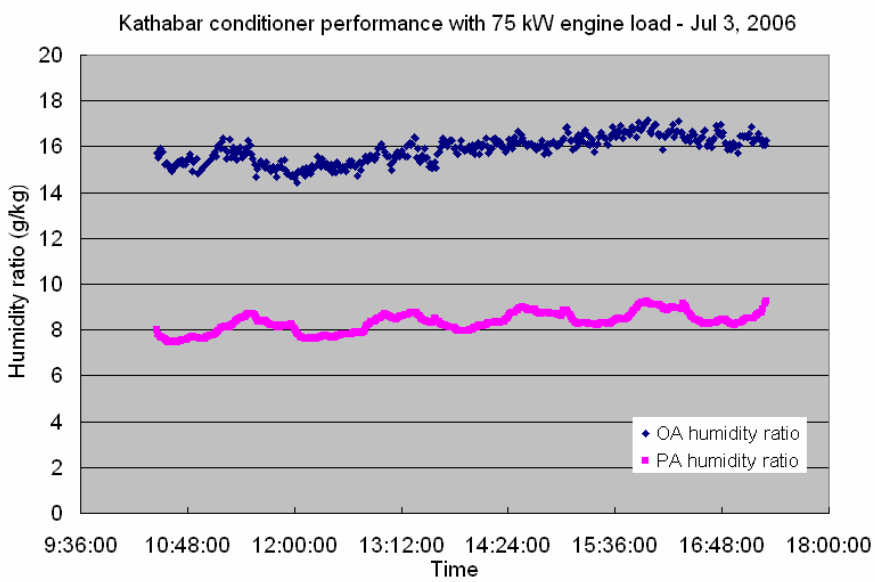

$$COP_{total,elec} = \frac{CoolCap_{total}}{ParasiticElectricalPower}$$

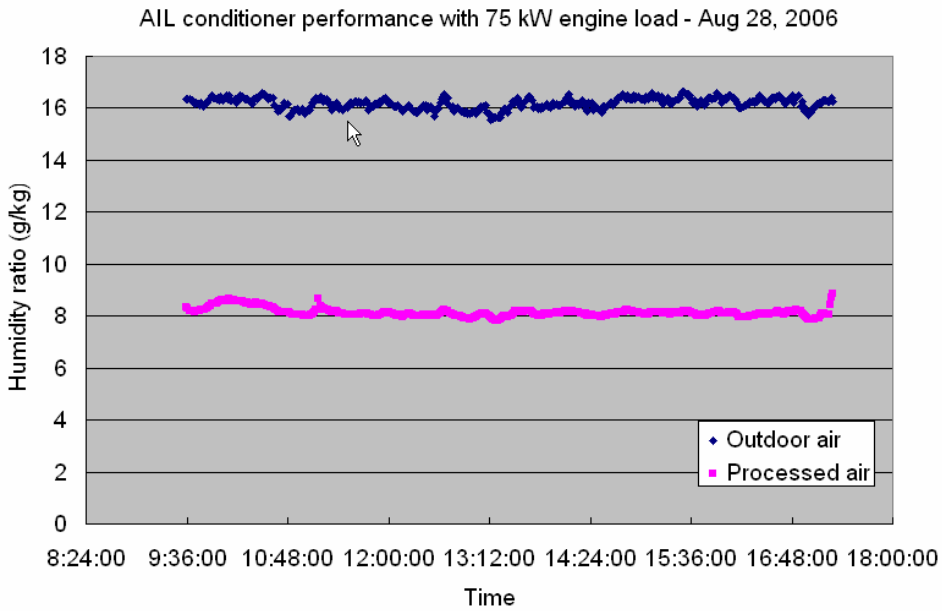
- The parasitic electrical power includes the power to run solution pumps, air supply fans as well as the associated cooling tower and controls.

- Desiccant flow rate for AIL conditioner is only **1.7gpm**. Comparing with about **20gpm** for the original system, it has great potential in saving the parasitic power.

# CHP SYSTEM 1

– *Comparison with Kathabar conditioner*




Jul 3, 2006: 90.1℉,52.0%, 15.9g/kg

Aug 28, 20006: 88.2℉,56.5%, 16.1g/kg

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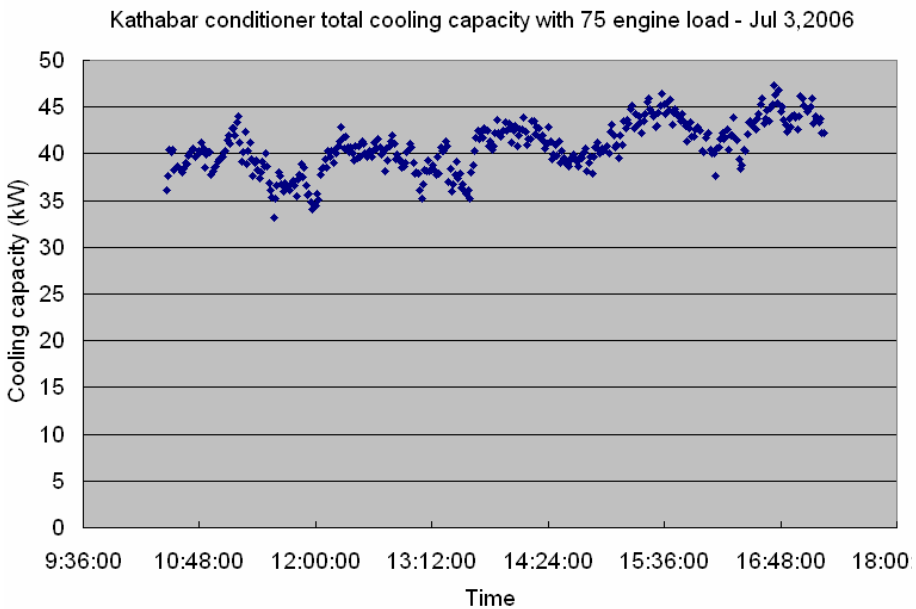


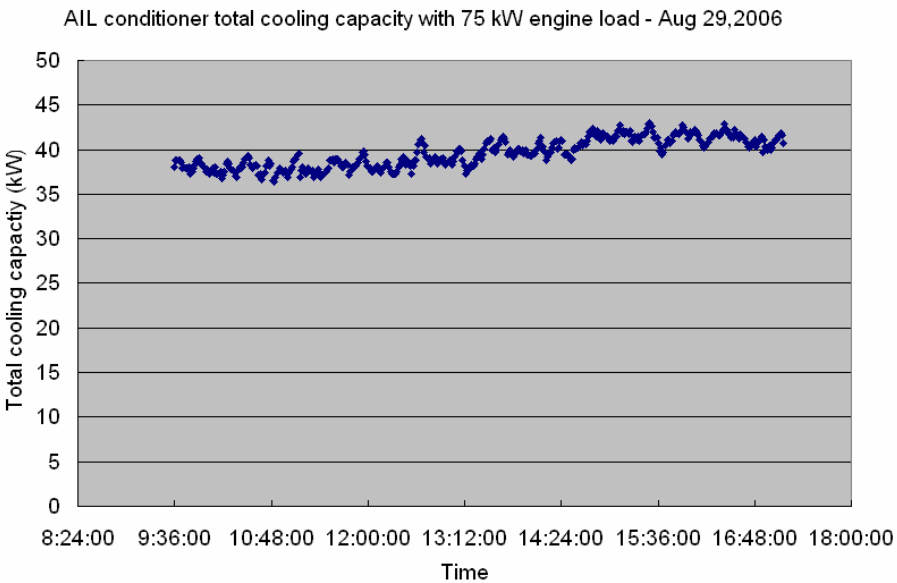


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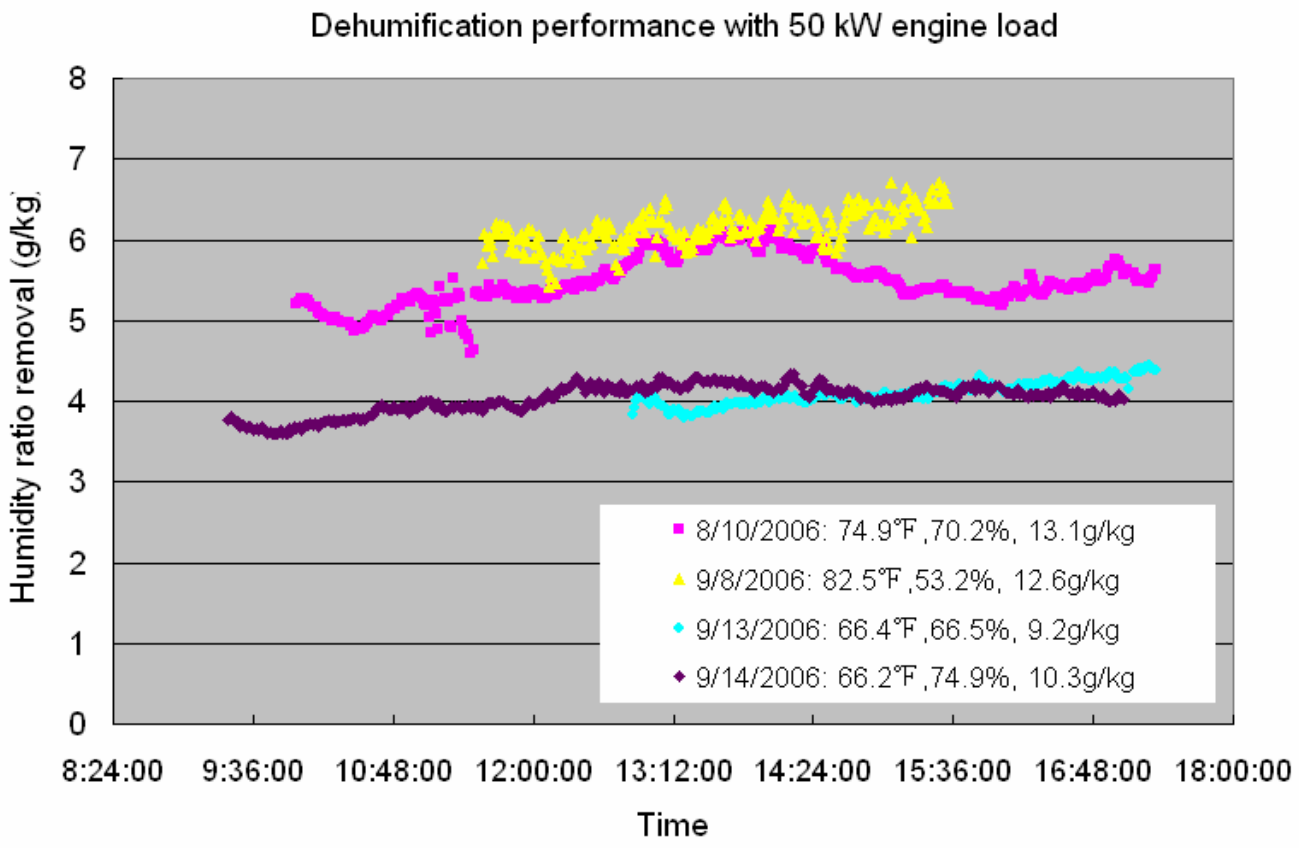
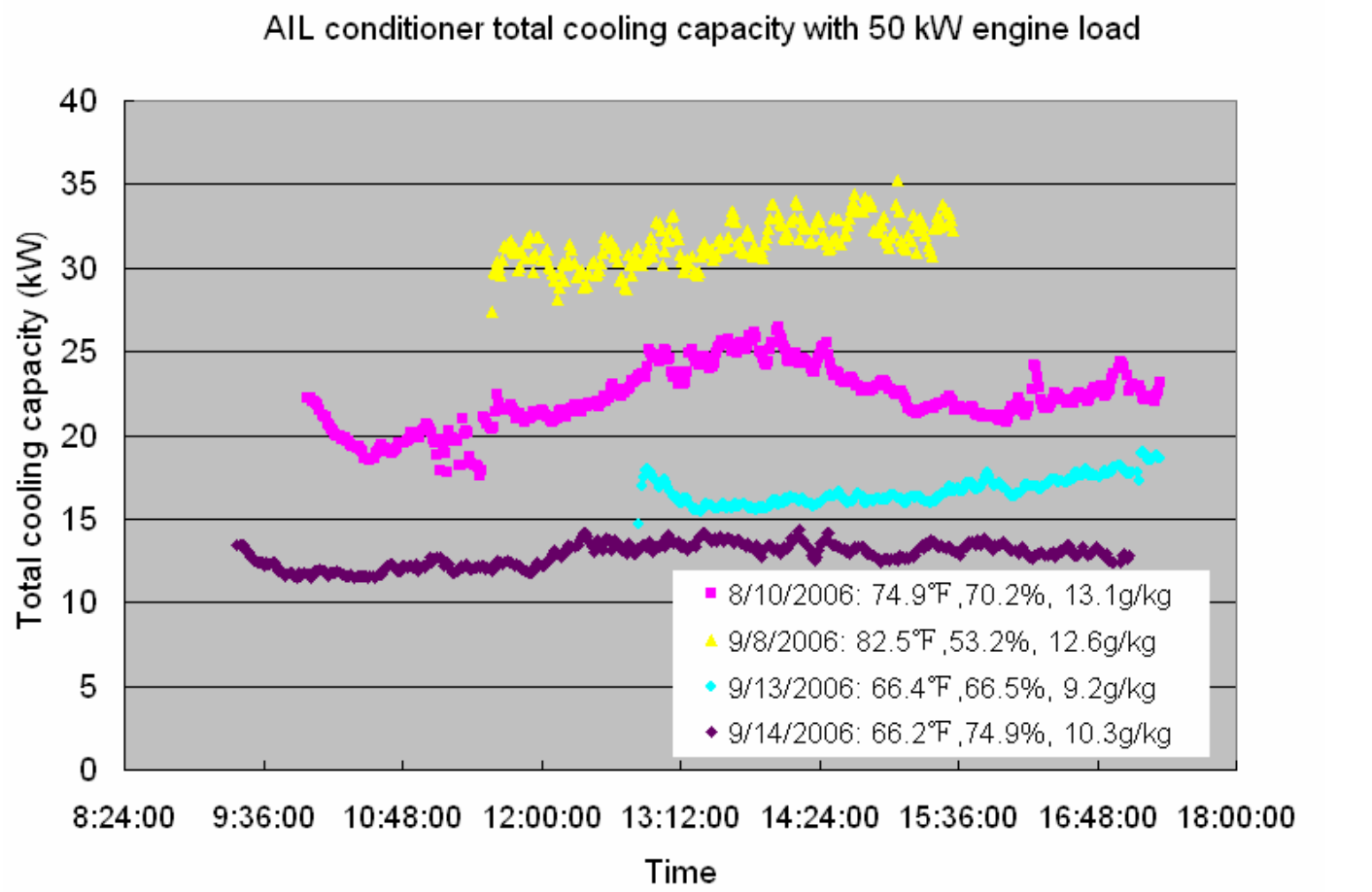



Humidity ratio removal = Outdoor air humidity ratio – Processed air humidity ratio

# CHP SYSTEM 1

– *AIL conditioner performance with 50 kW engine load, under variable outdoor air conditions.*



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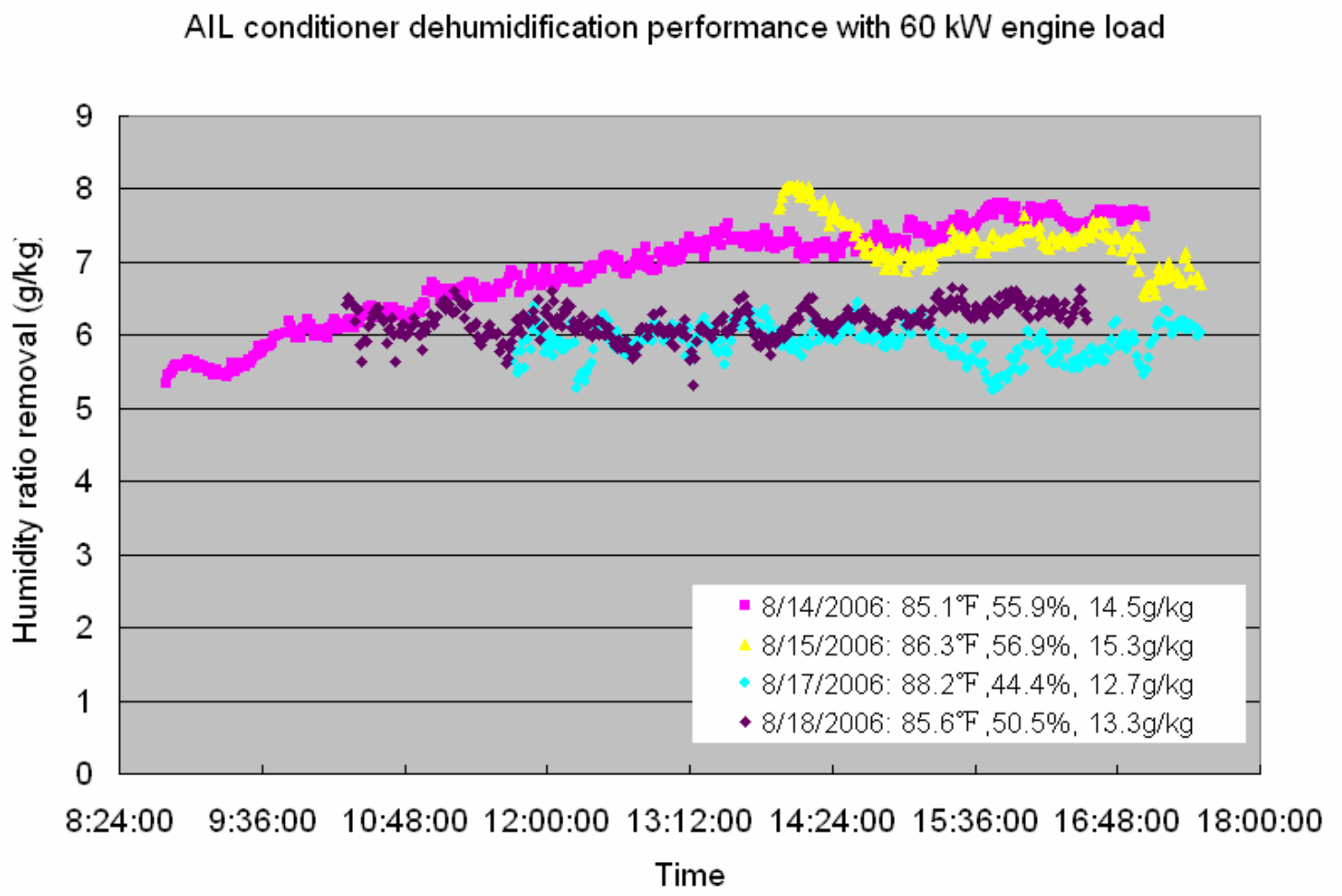

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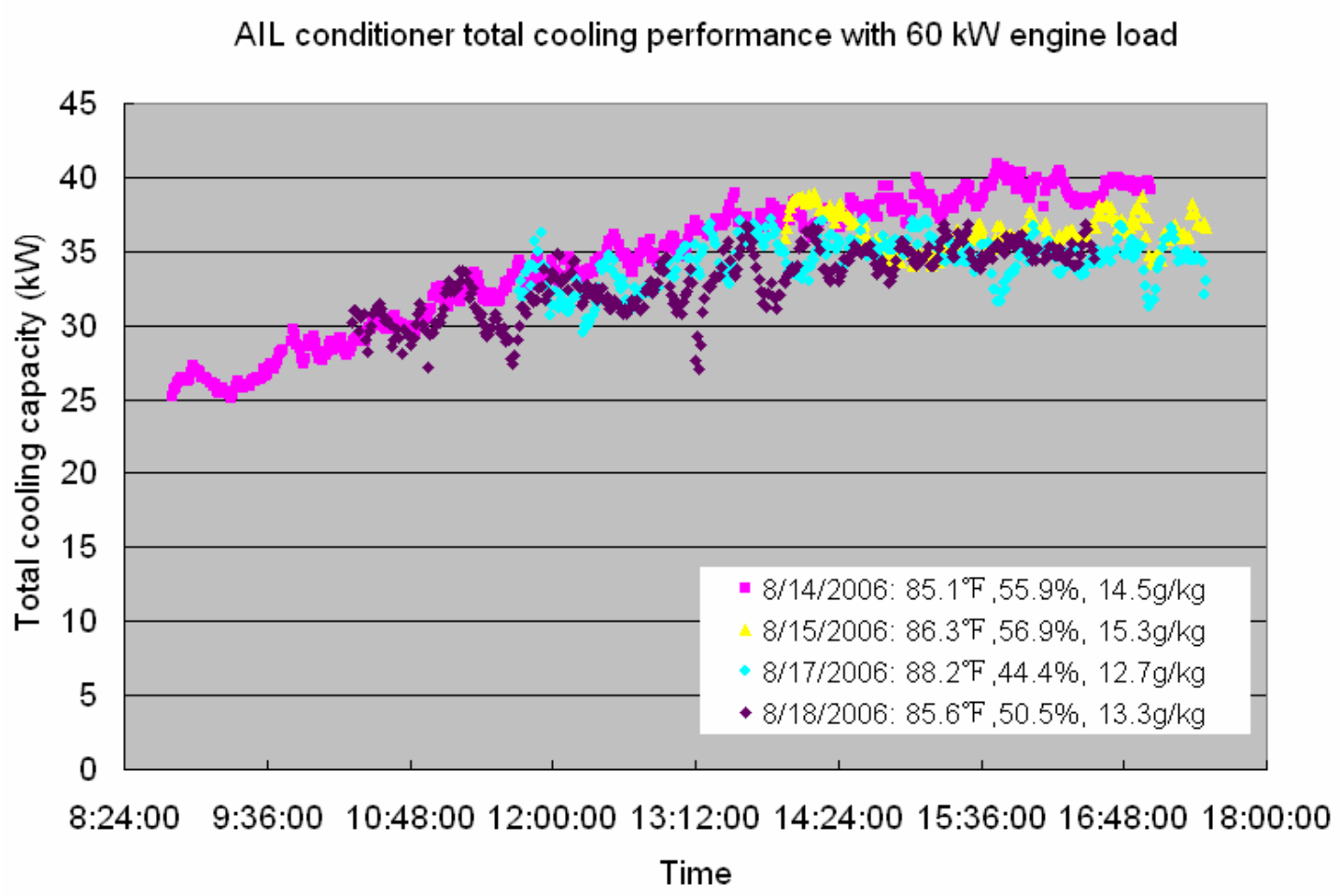
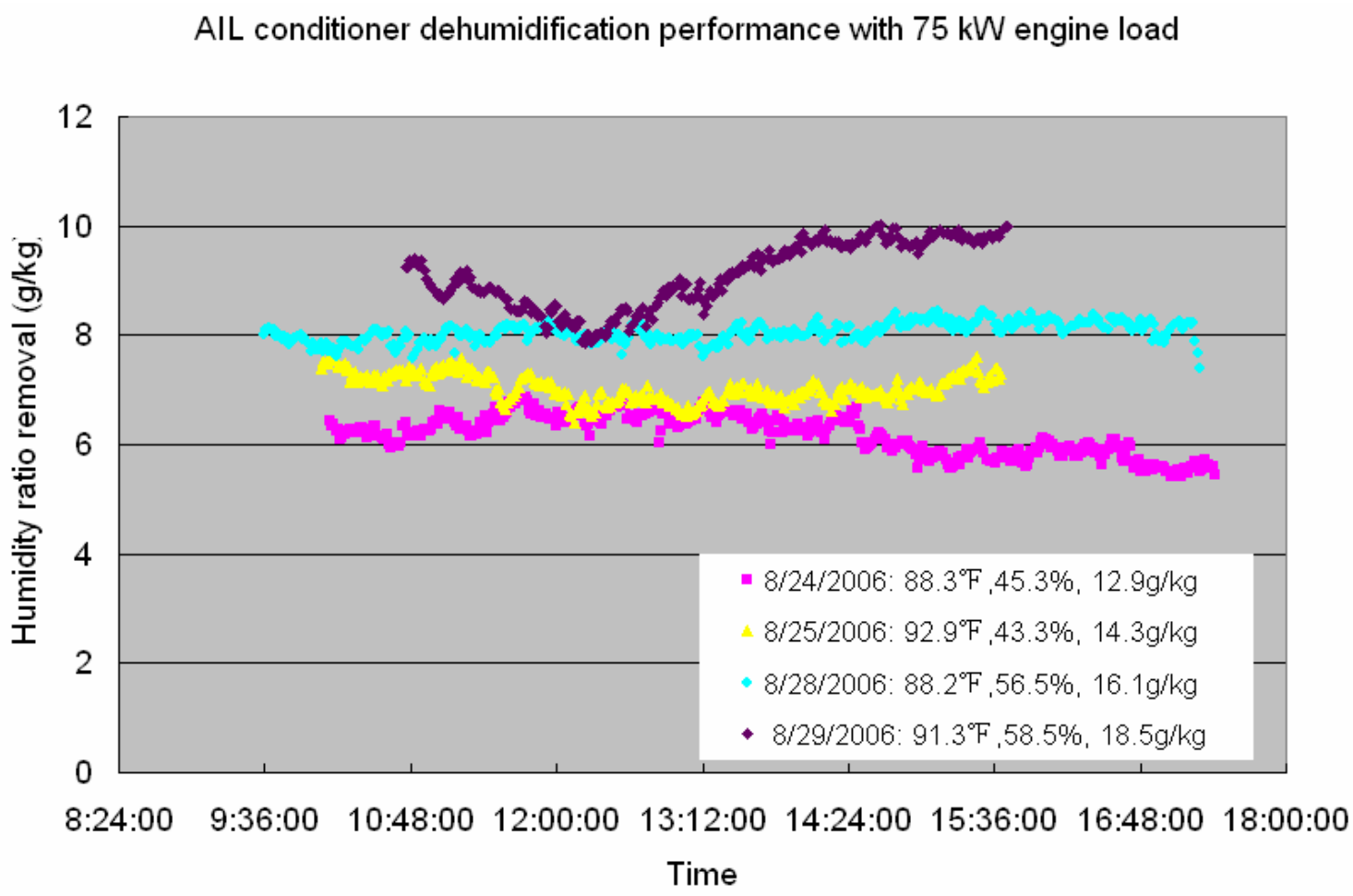


# CHP SYSTEM 1

– *AIL conditioner performance with 75 kW engine load, under variable outdoor air conditions.*



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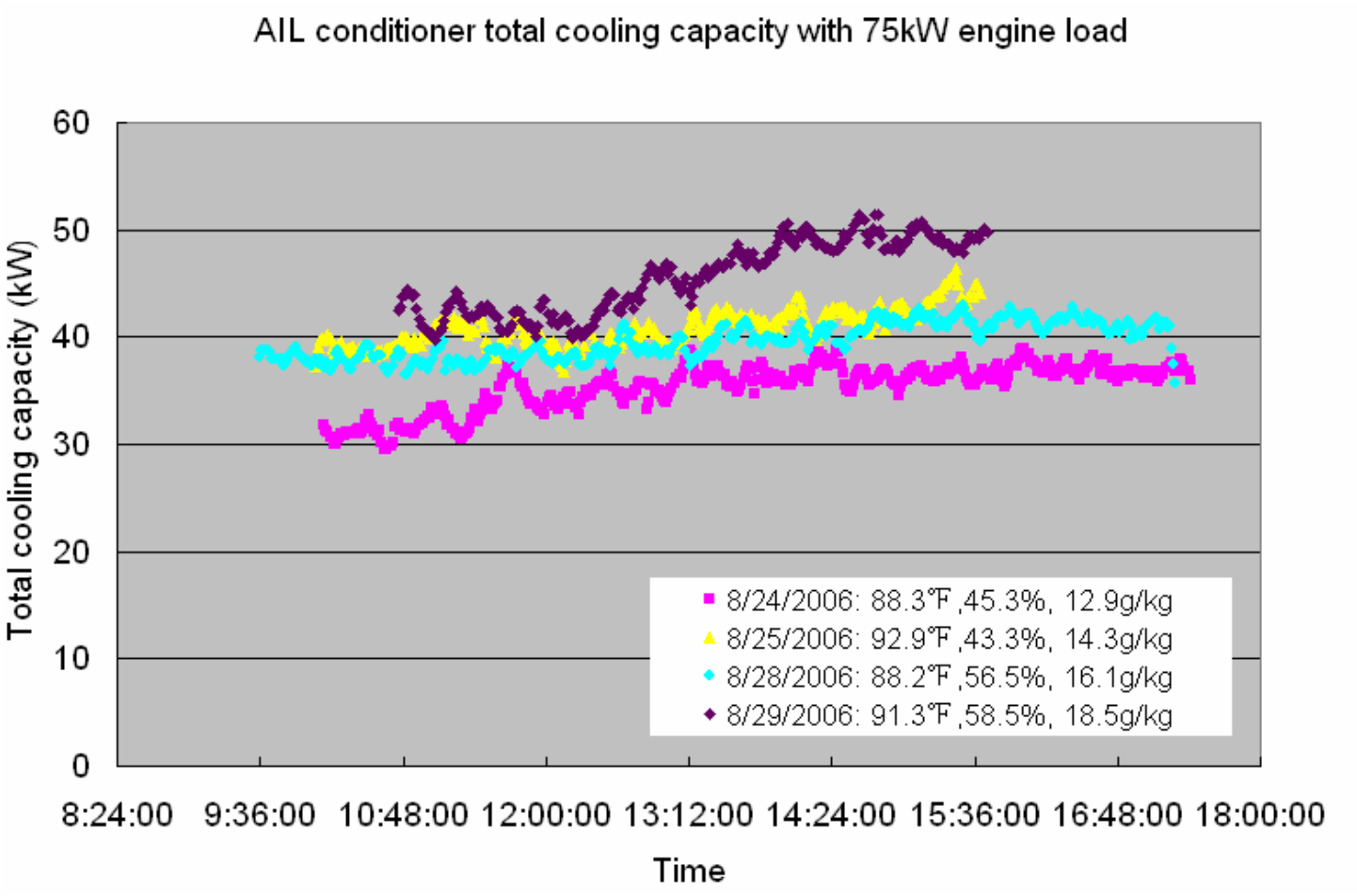

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*Thank you!*