NP 2016/2017 General Rate Application
Exhibit - DA-3
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MSHP vs Baseboard Electric

Direct Performance Comparison
April 2016

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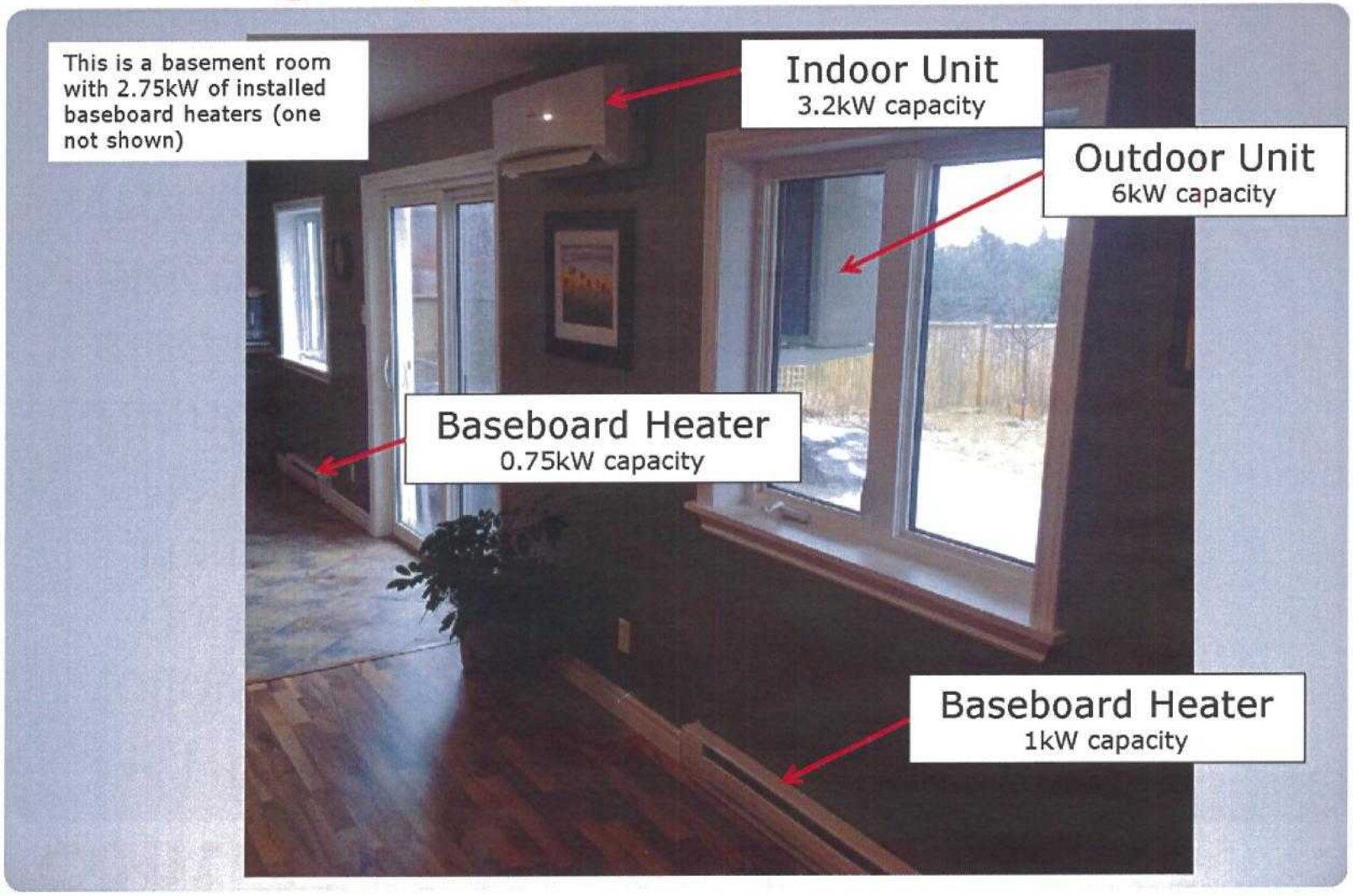
Overview of Study Case

- 10 year old home, registered R2000 construction, located in St. John's region
- 2 story, approximately 4000ft^2
  - Entire house temperature maintained at 22C, day and night, including developed basement and in-house garage (20C for garage)
  - Night setback not used since MSHP installed
- Initially built with baseboard heaters (20kW installed)
- Retrofitted with MSHP in Nov 2012 with additional units installed in Nov 2014.
  - 3 outdoor units, each with 2 indoor heads
  - Panasonic CU-2E18NBU outdoors, CS-E12NKUAW indoors
  - Baseboard heaters not used since Nov 2014
- Summer air conditioning available
- Installed MSHP heating capacity
  - 18kW rated (8C), 3 x 6kW
    - 20200Btu of heating each
    - Rated input 1.6kW each for COP of 3.75 at full load
  - Capacity reduces to 9.3kW @ -15C, 3 x 3.3kW
    - Rated input 1.4kW each for COP of 2.2 at full load
- Maximum installed heating demand
  - 20.0kW - Baseboard heaters
  - 4.8kW – MSHP (3 x 1.6kW)

Heating Equipment Comparison



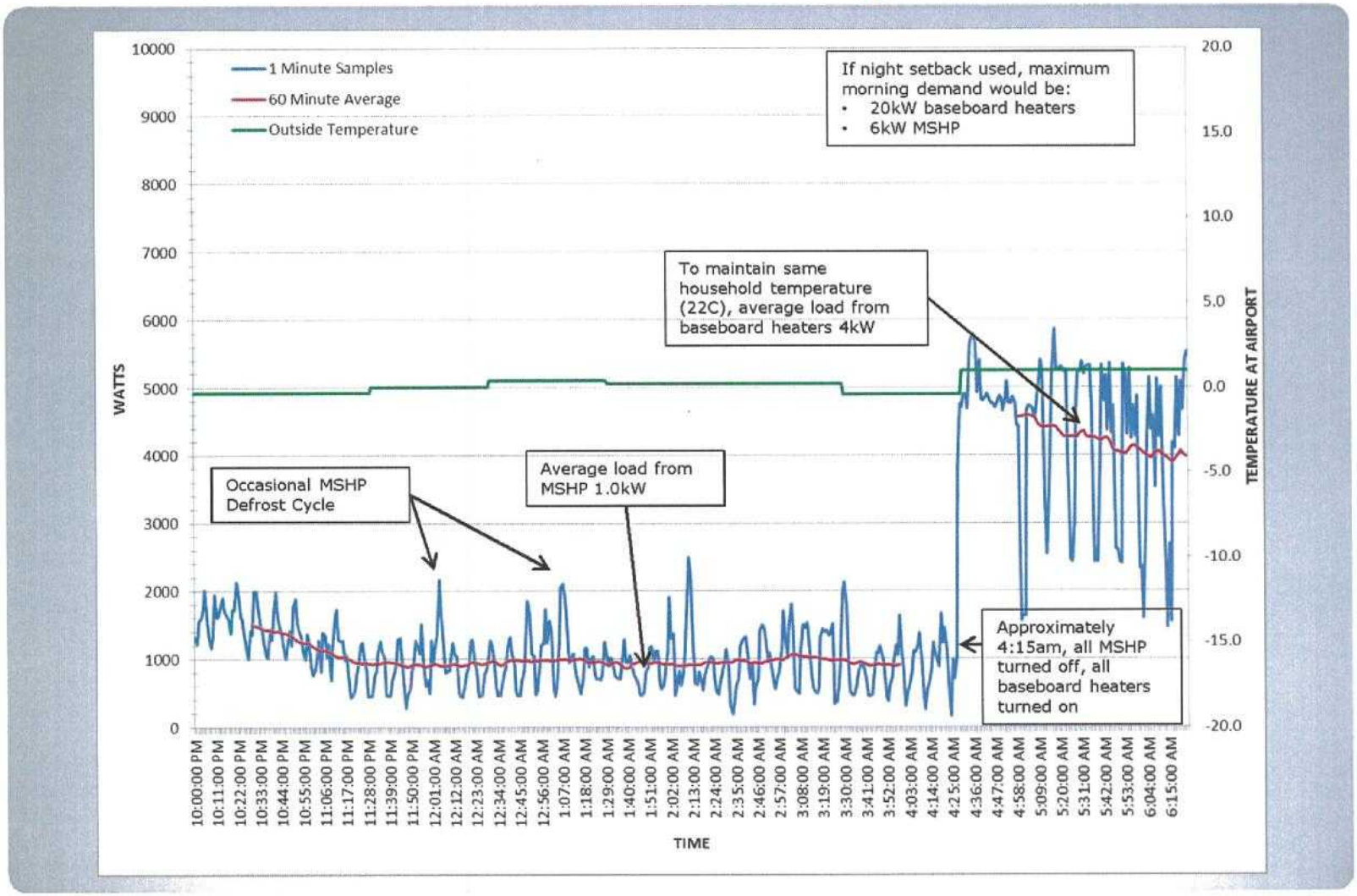
Control of Heaters

- MSHP operated in full auto mode. The following features are not used:
  - Quiet mode
  - Manual indoor fan speed control
  - Manual control of indoor louver direction
- Night setback not used for MSHP or electric baseboard heaters
- Electrical baseboard heaters controlled from electronic thermostats

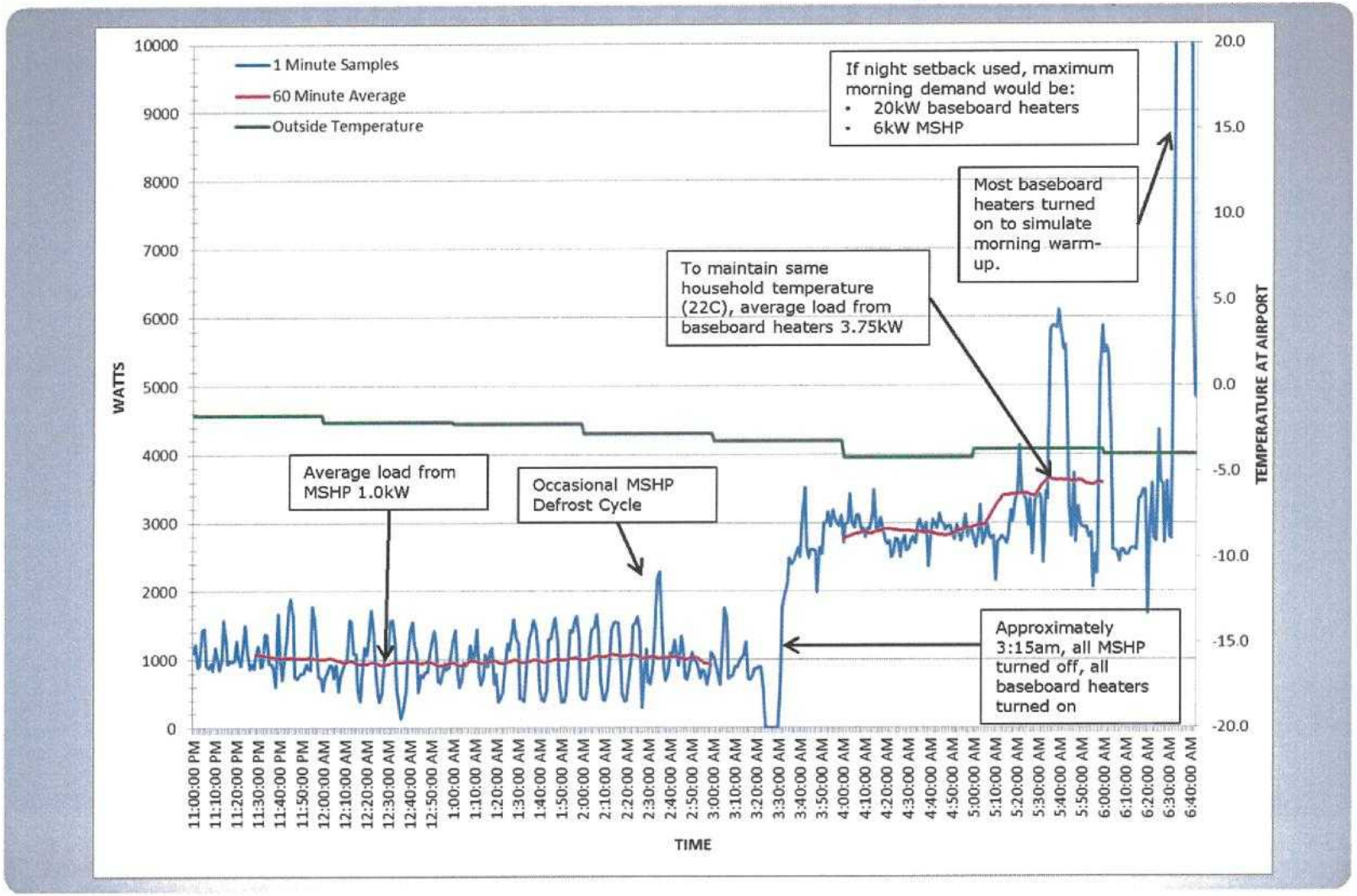
Testing Setup

- Home power monitoring system from Efergy
  - Measures current at main panel breaker (both wires) and multiplies by system voltage
  - System records power at 1 minute intervals
- Testing conducted at night (11pm-6am)
  - No effect from sun or household activities
  - All major appliances off, including hot water tank
- Heating 100% from MSHP for part of the night then switched to 100% electric baseboard heaters for the remainder
- Tests conducted during April:
  - Night of 7th — 0C overnight (heaters first, then MSHP)
  - Night of 11th — -3C overnight (heaters first, then MSHP)
  - Night of 6th — -8C overnight (MSHP first, then heaters)

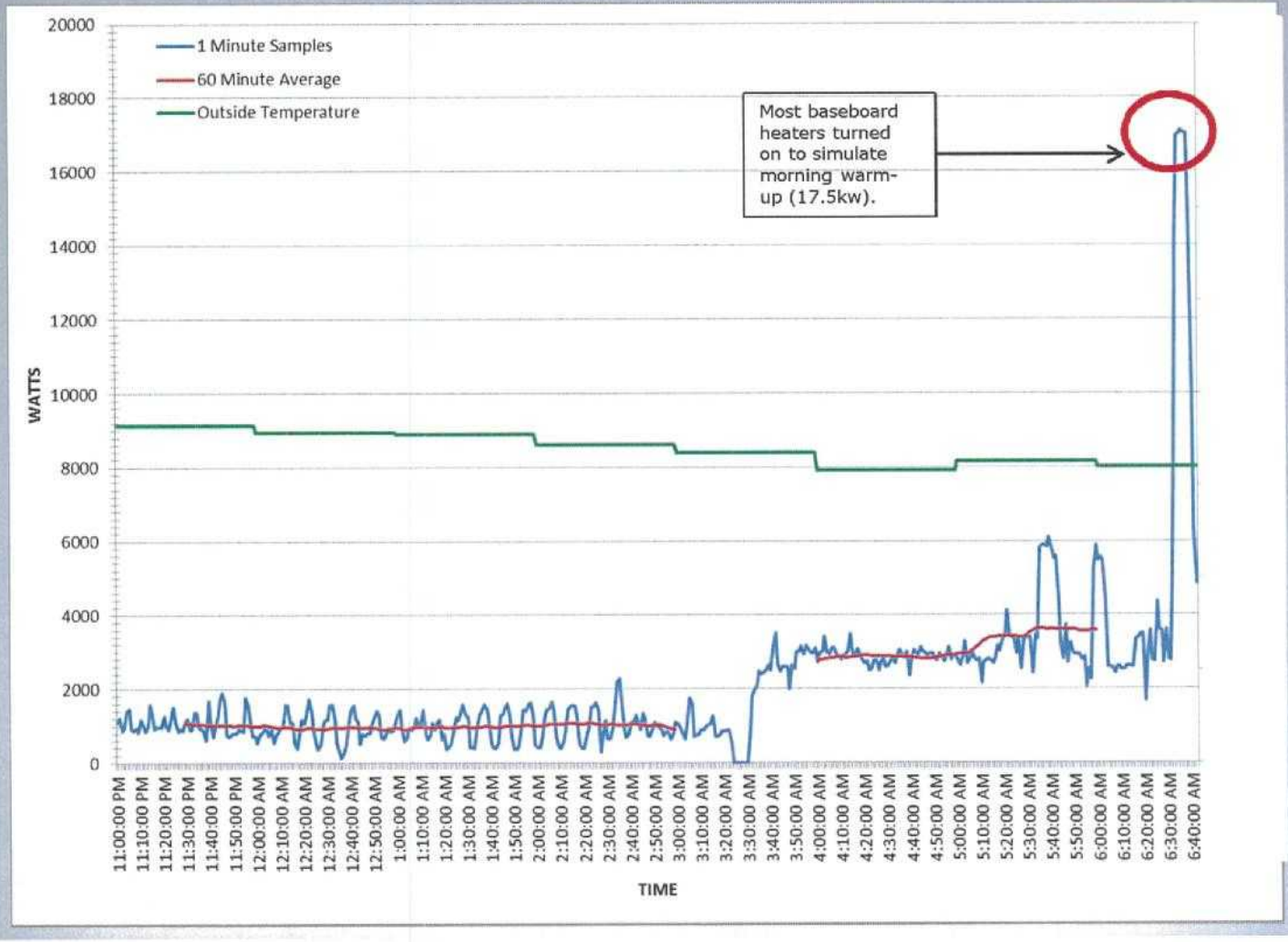
0C Performance Graph



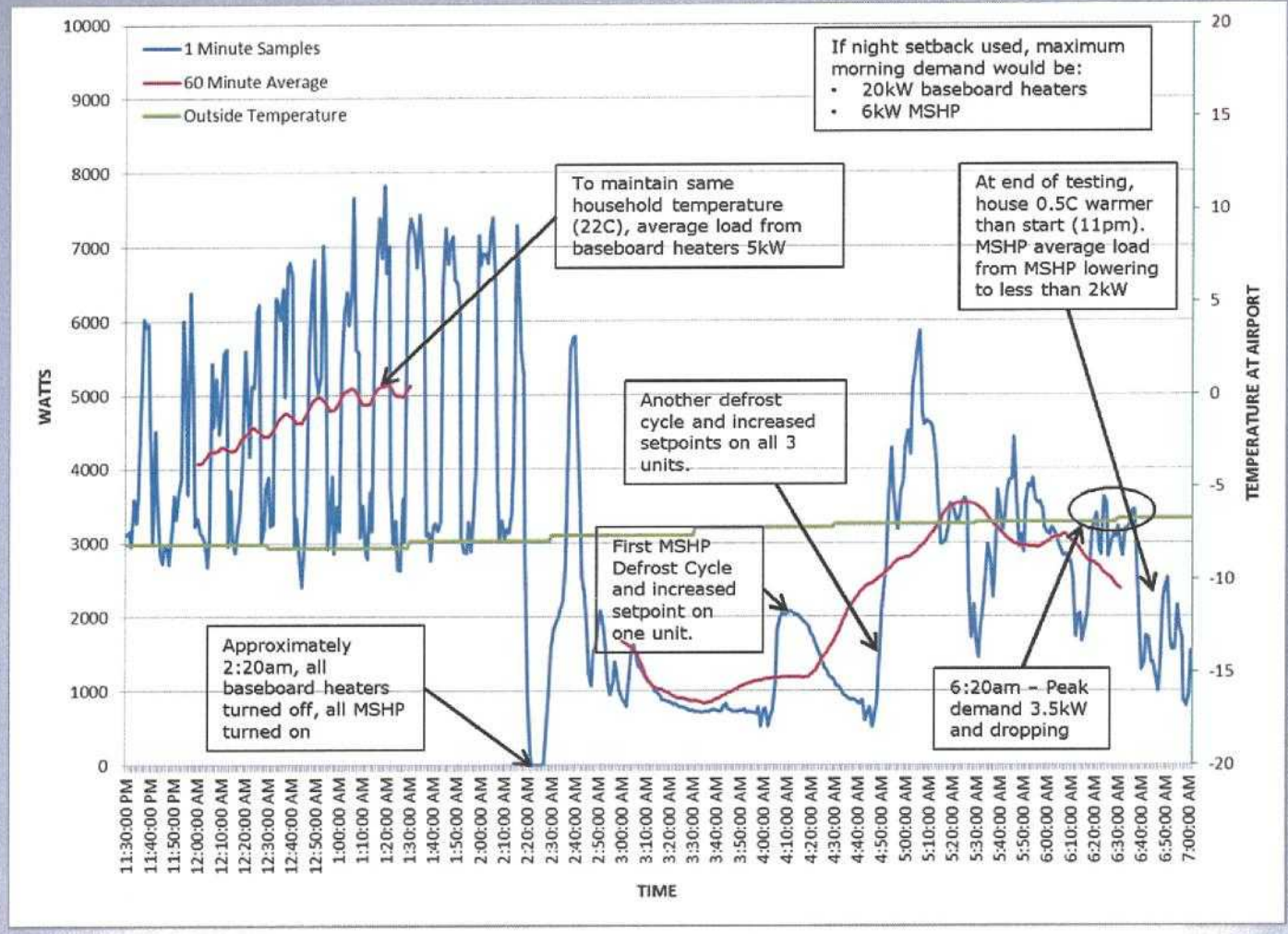
-3C Performance Graph



Morning Warmup



-8C Performance Graph



Results Summary

- Heating requirements to maintain entire house at 22C (red line)

Outside Temperature	Wind Speed (km/hr)	House Heating Requirements	Baseboard Heater Load	MSHP Load	MSHP COP
0C,	25-40	4.0kW	4.0kW	1.0kW	4.0
-3C	5-25	3.5kW	3.5kW	1.0kW	3.5
-8C,	40-55	5.0kW	5.0kW	2.0kW	2.5

- Peak Demand (blue line)

Outside Temperature	Baseboard Heater	MSHP	Demand Savings
0C	5.9kW	2.5kW	3.4kW
-3C	6.0kW	2.5kW	3.5kW
-8C	7.8kW	3.5kW*	4.3kW

* 3.5kW taken at 6:20am after house temperature increased to 22.5C.

Conclusions

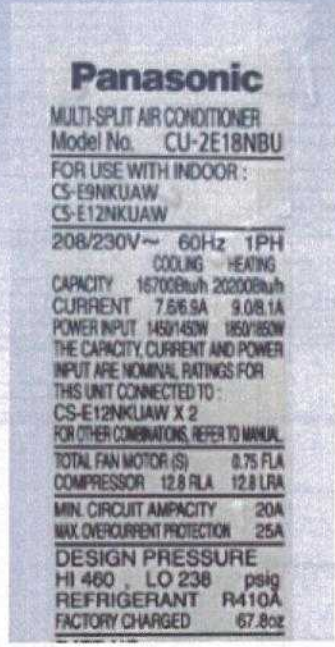
- MSHP whole house systems can be installed to heat house efficiently by sizing units for low temperature extremes:
  - 2:1 – MSHP COP at low temperature extremes
  - 4:1 – MSHP COP at 0C
- Performance at 0C:
  - 75% lower – MSHP energy use vs electrical baseboard
  - 60% lower – peak demand of MSHP vs electrical baseboard heaters
- Maximum MSHP heating demand always lower than electric baseboard heaters
- Defrost cycles have little effect on system efficiency, household comfort
- Night setback should not be use with MSHP system

Backup Material

- MSHP Nameplate
- MSHP Specifications
- MSHP Operating Curves
- Efergy Metering System

MSHP Nameplate

- Outdoor unit

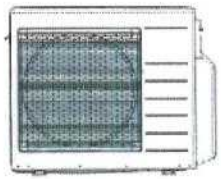


MSHP Specifications

Order No: PHAAM1111202A1

Service Manual

Air Conditioner



Outdoor Unit
CU-2E18NBU

Please file and use this manual together with the service manual for Model No. CS-E9NKUAW CS-E12NKUAW. Order No. PHAAM1111208C1.

⚠ WARNING

This service information is designed for experienced repair technicians only and is not designed for use by the general public.
It does not contain warnings or cautions to advise non-technical individuals of potential dangers in attempting to service a product.
Products powered by electricity should be serviced or repaired only by experienced professional technicians. Any attempt to service or repair the product or products dealt with in this service information by anyone else could result in serious injury or death.

⚠ PRECAUTION OF LOW TEMPERATURE

In order to avoid hazards, be assured of no refrigerant leakage during the installation or repairing of refrigerant circuit.

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Panasonic

2. Specifications

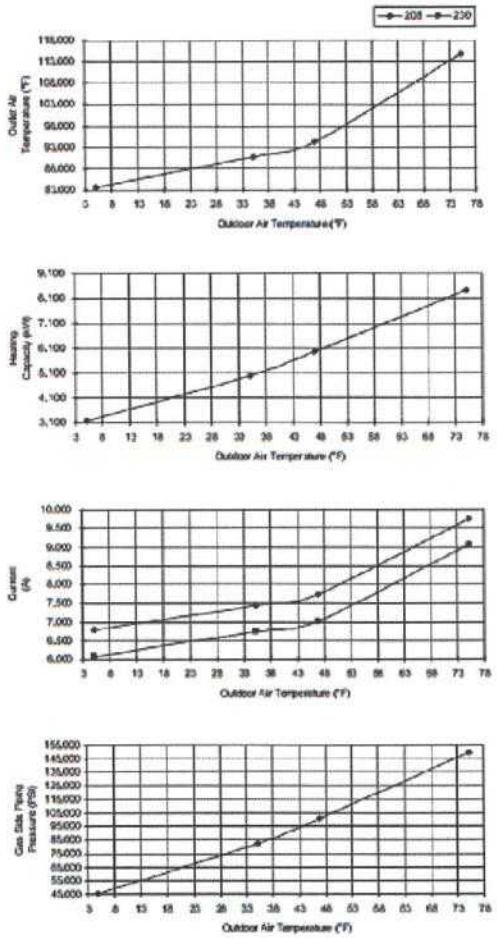
2.1 CU-2E18NBU

Item			Unit	OUTDOOR UNIT
Indoor Unit Combination				3.2kW + 3.2kW
Power Source				1 Phase, 208 ~ 230V, 60Hz (Power supply from outdoor unit)
Cooling Operation	Capacity		kW	4.89 (2.16 ~ 5.86)
			BTU/h	16700 (7300 ~ 20000)
	Electrical Data	Running Current	A	7.8 ~ 6.9
		Power Input	kW	1.48 (0.39 ~ 1.84)
		EER	W/W	3.37 (5.38 ~ 3.18)
			BTU/hW	11.50 (18.45 ~ 10.85)
	Noise	Sound Pressure Level	dB-A	48
		Sound Power Level	dB	60
Heating Operation	Capacity		kW	5.84 (2.11 ~ 7.28)
			BTU/h	20200 (7200 ~ 24800)
	Electrical Data	Running Current	A	9.0 ~ 8.1
		Power Input	kW	1.85 (0.42 ~ 2.29)
		COP	W/W	3.21 (5.02 ~ 3.14)
			BTU/hW	10.90 (17.15 ~ 10.75)
	Noise	Sound Pressure Level	dB-A	49
		Sound Power Level	dB	63
Maximum Current			A	13.8
Starting Current			A	9.0
Maximum Circuit Ampacity			A	20
Dimension	Height		mm (inch)	795 (31-5/16)
	Width		mm (inch)	875 + 95 (34-15/32 + 3-3/4)
	Depth		mm (inch)	323 (12-3/8)
Net Weight			kg (lb)	66 (152)
Connection cable				3 + 1 (Earth) ø1.5 mm²
Pipe Length Range (1 room)			m (ft)	3 ~ 25 (9.8 ~ 82.0)
Maximum Pipe Length (Total Rooms)			m (ft)	50 (164.0)
Refrigerant Pipe Diameter		Liquid Side	mm (inch)	6.35 (1/4)
		Gas Side	mm (inch)	9.52 (3/8)
Compressor		Type		Hermetic Motor
		Motor Type		DC Brushless (4-poles)
		Rated Output	W	1,300
Air Circulation		Type		Propeller Fan
		Motor Type		DC Brushless (8-poles)
		Rated Output	W	60
Fan Speed		High	RPM	870
Heat Exchanger		Type		Plate fin configuration forced draft type
		Tube Material		Copper
		Fin Material		Aluminum
		Row/Stage		3/36
		FPI		19

- **Heating Characteristic**

[Condition] Room temperature: 68°F (DBT)
Operation condition: High fan speed
Piping Length: 24.6ft
Compressor Freq: Fh

B) Indoor unit capacity: Heating (3.2 + 3.2: CS-E12NKUAW + CS-E12NKUAW), service mode frequency = 63Hz



Efergy Power Monitoring

- http://efergy.com/ca/