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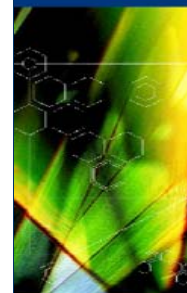
# Emissions from Domestic Heaters

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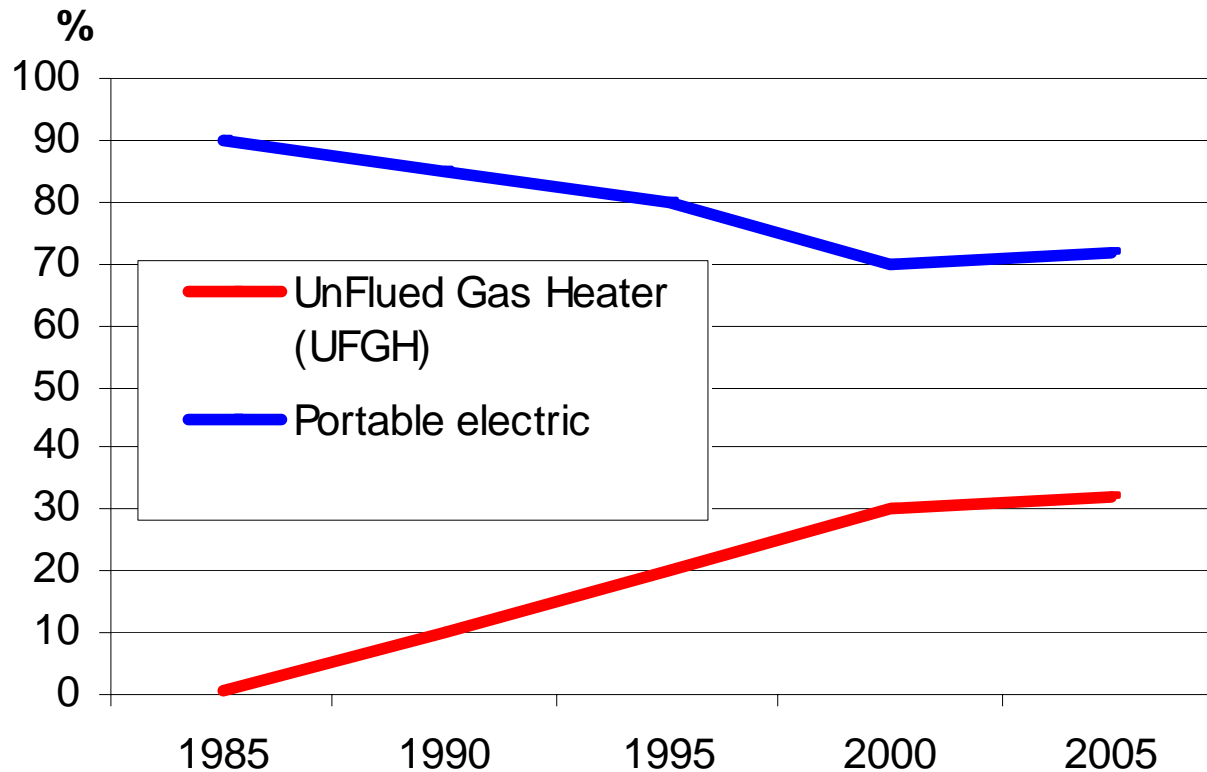
<sup>2</sup> *Building Research Association of New Zealand, Porirua, New Zealand*



# Background

- Houses in New Zealand are on average too damp and cold in winter, and emissions from some heaters cause respiratory irritation
- Building insulation deficiency,
- Low capital cost heater such as portable electric (PE) heaters and unflued gas heaters (UFGH) are typically used and they are only used for short periods and in one or two rooms,

## Heat Sources In New Zealand Households (Household Economic Survey)



*(N.Isaacs, personal communication)*

A study to investigate the emissions from domestic heaters was nested within the Housing, Heating and Health Study (407 families with asthmatic child enrolled in the HHH study in 5 New Zealand centres)

Sub study consisted of intensive monitoring of indoor air for up to 1 week in homes in the Hutt Valley



# Objective

To investigate the emissions generated by domestic heaters.

Emissions measured included nitrogen dioxide, carbon monoxide, carbon dioxide, formaldehyde, relative humidity and temperature.



# Method

- The homes had been insulated (roof and under floor) before the study started.
- Measurements were made in living room (main heating source) and the asthmatic child's bedroom during the winters of 2005 and 2006



# Instruments

Formaldehyde  
sensor and logger

Temperature,  
relative humidity,  
carbon dioxide and  
carbon monoxide  
sensor and data  
logger



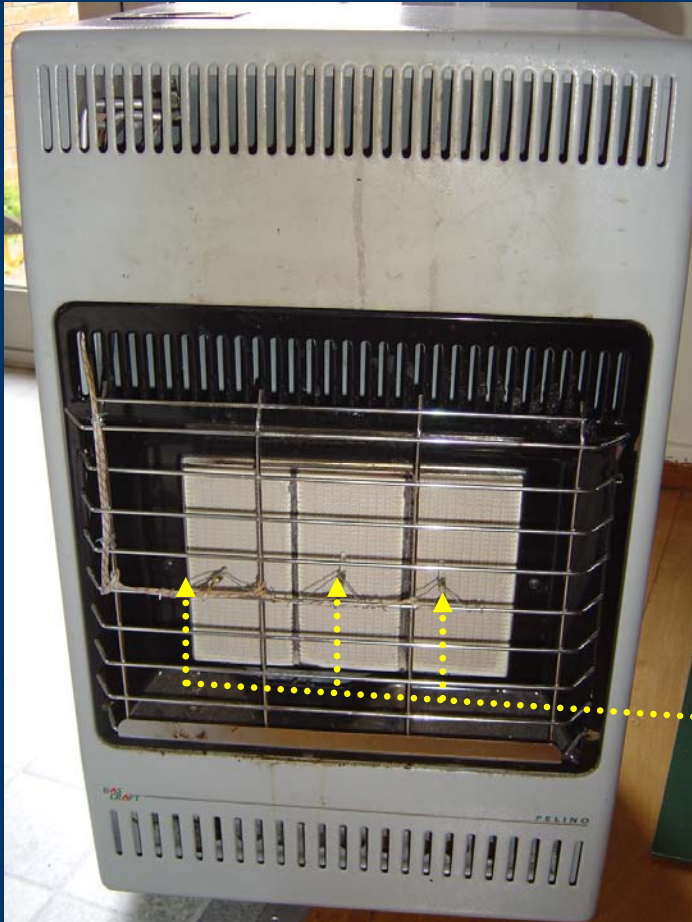




NO2 analysers were installed in the ceiling cavity with sampling tubes to bedroom and living room







Logger

Type K thermocouples

Thermocouples or powerloggers were installed on all heaters to measure heater



# Participants

- winter 2005

- 33 families
- using either an unflued gas heater and/or an electric heater as their main heating source

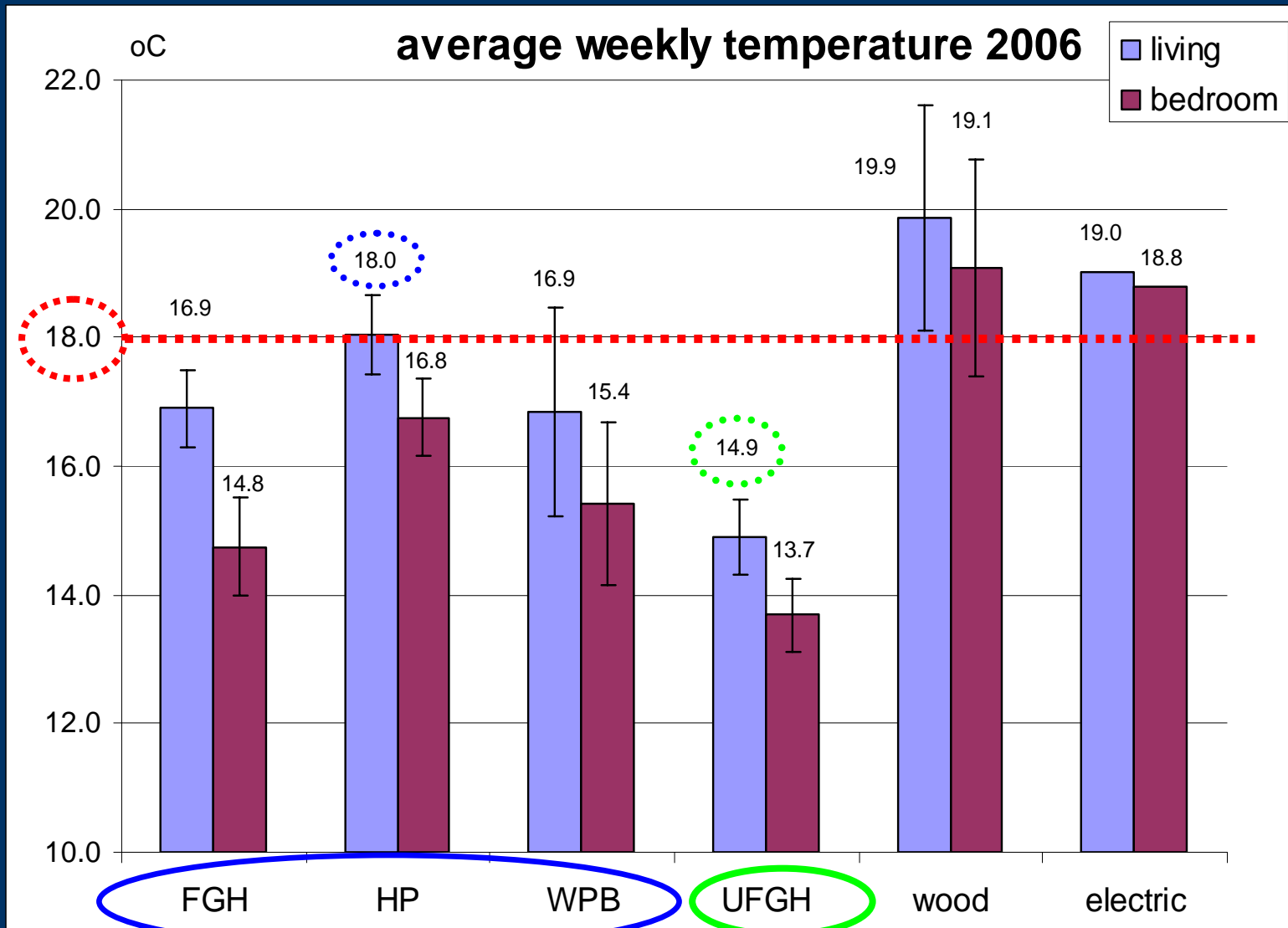
- winter 2006

- 36 families
- Control Group (unflued gas heater or/and electric heater)
- Intervention group (heat pump, flued gas heater, wood pellet burner)



Heater type	05	06
UFGH	38	25
Portable electric	27	35
Heat pump		15
Flued gas heater	1	3
Wood pellet burner		4
Wood burner	6	5

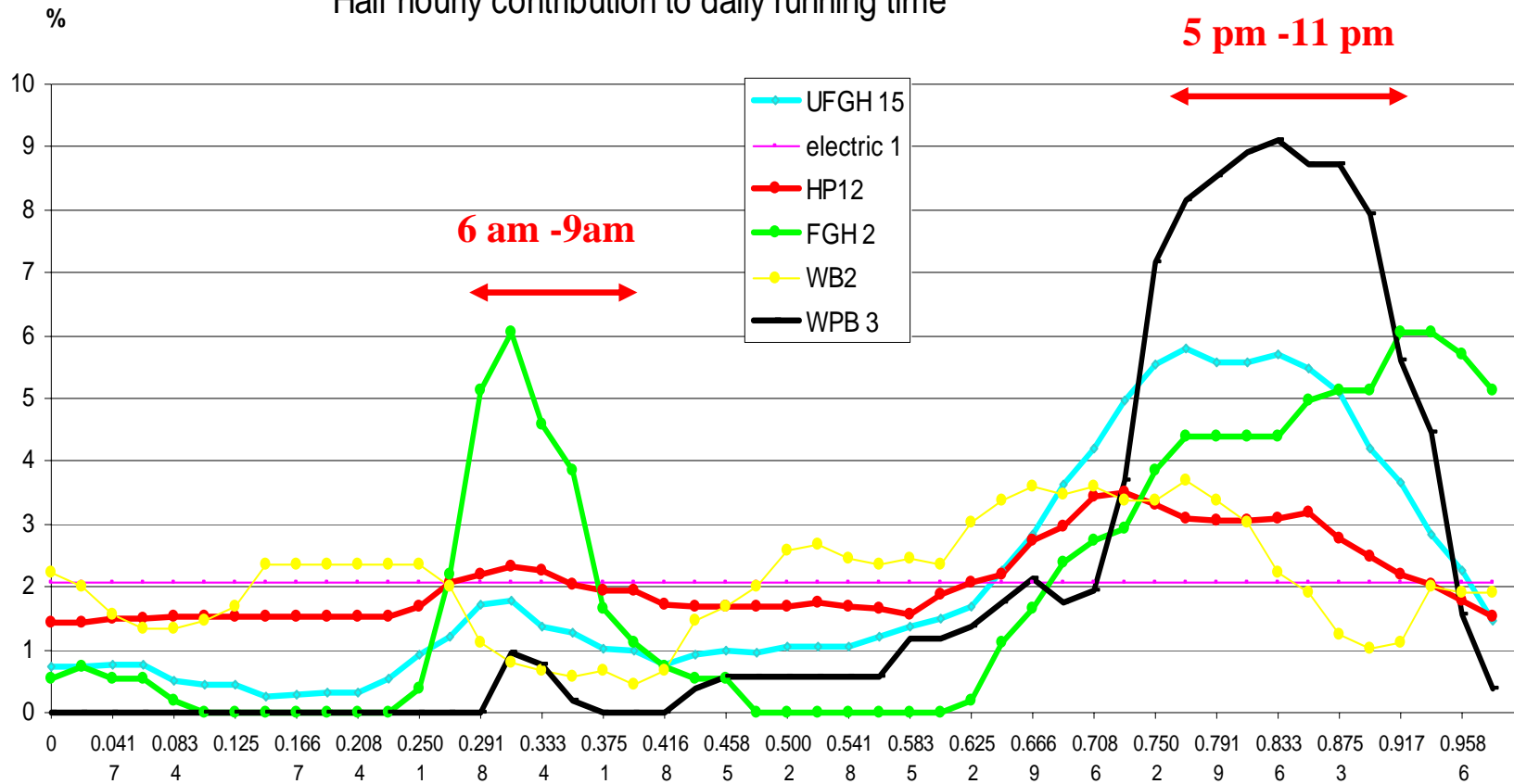




Outside temp :  $7.62 \pm 0.02$  -  $9.49 \pm 0.02$  °C

# Heater usage

Half hourly contribution to daily running time



- WPB, UFGH & FGH : morning & evening running time
- People operated HP for longer than other types of heaters

# Temperature and Humidity

- Homes with a new heater installed were 1-2°C warmer than homes using their original heaters, but were still below the WHO recommendations of 18°C to 24°C.
- Homes with a new heater had relative humidity levels on average 7% lower in the lounge room and 6% lower in the bedroom.
- Preliminary results show a reduced level of viable fungi in 2006 than 2005. Bedroom had much higher levels of fungi than living rooms.





# Emissions from heaters

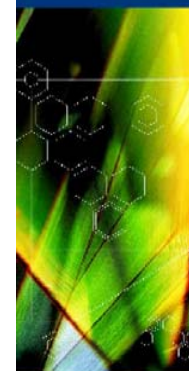
Compound	Range	Averag	Std	95% conf.	Guideline values	
<b>Portable Electric Heater</b>					Short term	Long term
NO2 (ppb)	0-13	1	4	0.9	23	110
Formaldehyde (ppm)	0.00-0.23	0.04	0.04	0.01	0.04	0.08
CO2 (ppm)	420-1952	872	278	70.4	1000	5000
CO (ppm)	0.0-3.2	0.3	0.7	0.2	9	25
<b>UFGH</b>						
NO2 (ppb)	<b>23-614</b>	<b>119</b>	77	13	<b>23</b>	<b>110</b>
Formaldehyde (ppm)	<b>0.00-0.20</b>	<b>0.06</b>	0.04	0.01	<b>0.04</b>	<b>0.08</b>
CO2 (ppm)	<b>593-5609</b>	<b>1759</b>	971	161	<b>1000</b>	<b>5000</b>
CO (ppm)	<b>0.0-16.1</b>	<b>2.5</b>	3.1	0.5	<b>9</b>	<b>25</b>

# Emissions from heaters

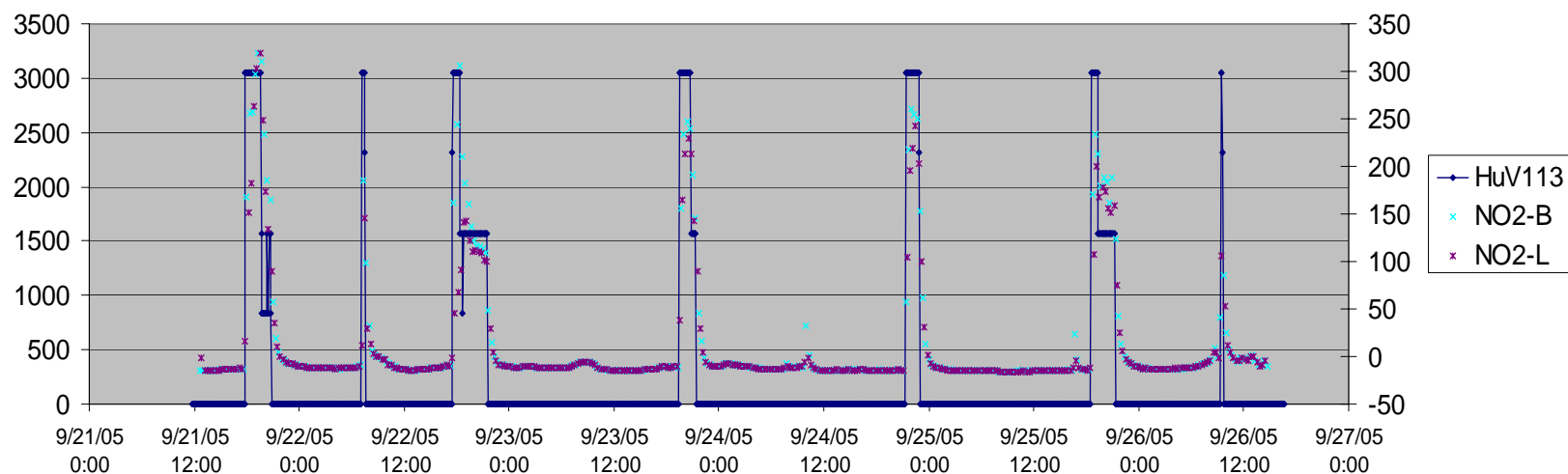
Compound	Range	Averag	Std	95% conf.	Guideline values	
<b>Heat Pumps</b>					Short term	Long term
NO2 (ppb)	0-14	4	4	1	23	110
Formaldehyde (ppm)	0.00-0.06	0.02	0.01	0.01	0.04	0.08
CO2 (ppm)	319-995	660	175	72	1000	5000
CO (ppm)	0.0-0.5	0.1	0.1	0.1	9	25
<b>Flued gas</b>						
NO2 (ppb)	2-30	13	9	4	23	110
Formaldehyde (ppm)	0.00-0.07	0.01	0.02	0.01	0.04	0.08
CO2 (ppm)	546-1198	763	219	115	1000	5000
CO (ppm)	0.0-3.5	1.1	1.4	0.7	9	25

# Emissions from heaters

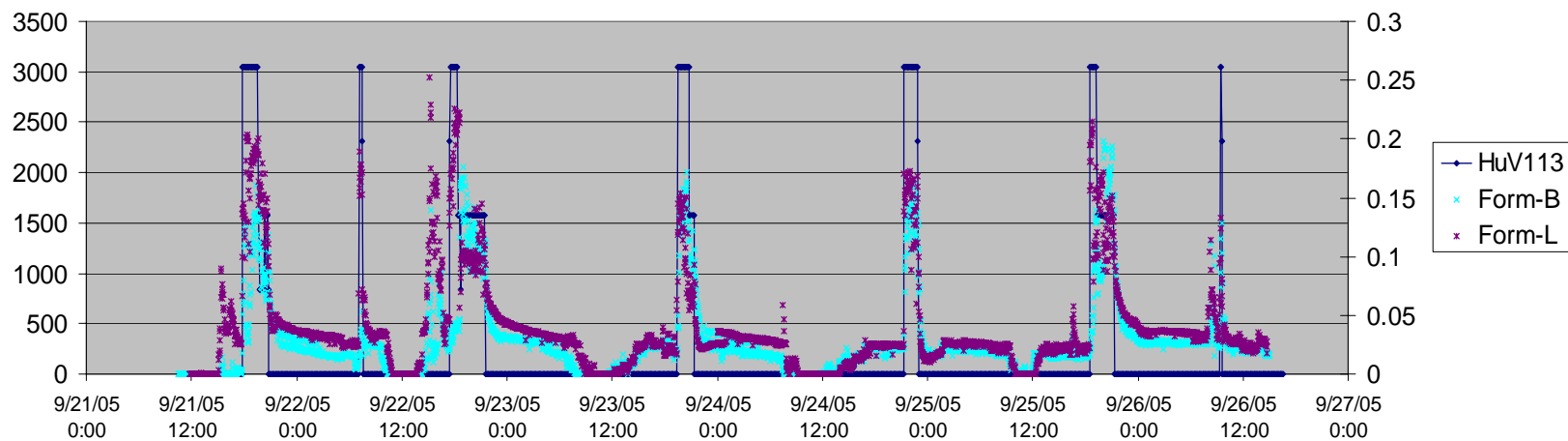
Compound	Range	Averag	Std	95% conf.	Guideline values	
<b>Wood Pellet Burner</b>					Short term	Long term
NO2 (ppb)	1-5	3	2	2	23	110
Formaldehyde (ppm)	0.02-0.03	0.02	0.01	0.01	0.04	0.08
CO2 (ppm)	547-717	632	70	68	1000	5000
CO (ppm)	0.0-0.1	0.0	0.0	0.0	9	25



## NO2



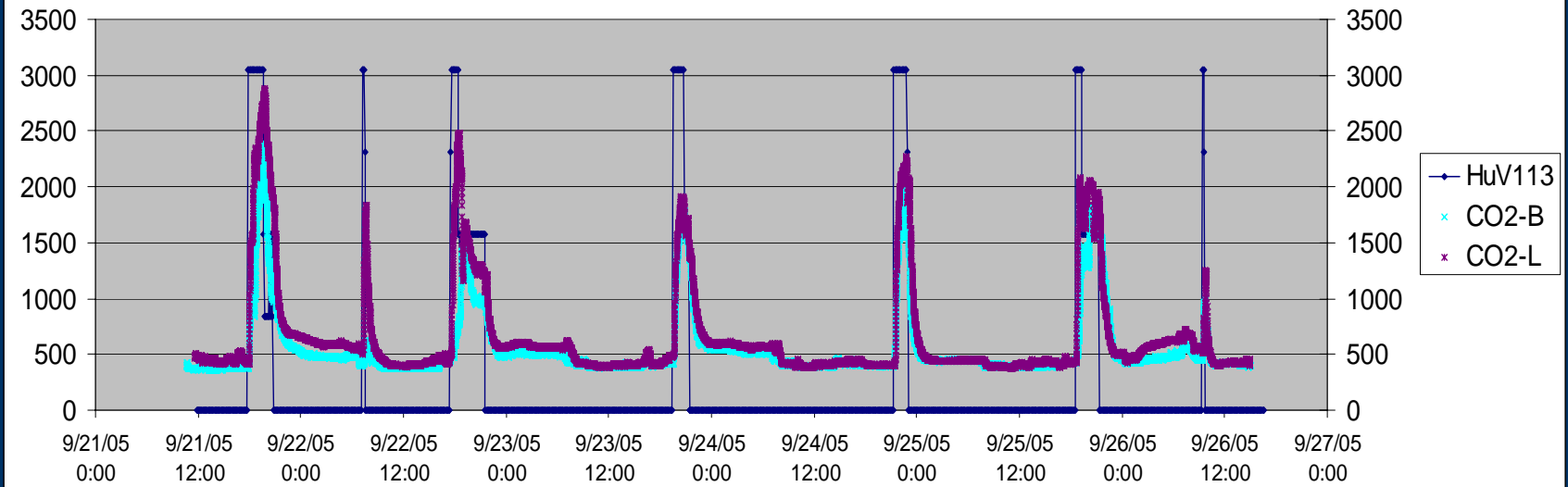
## Formaldehyde



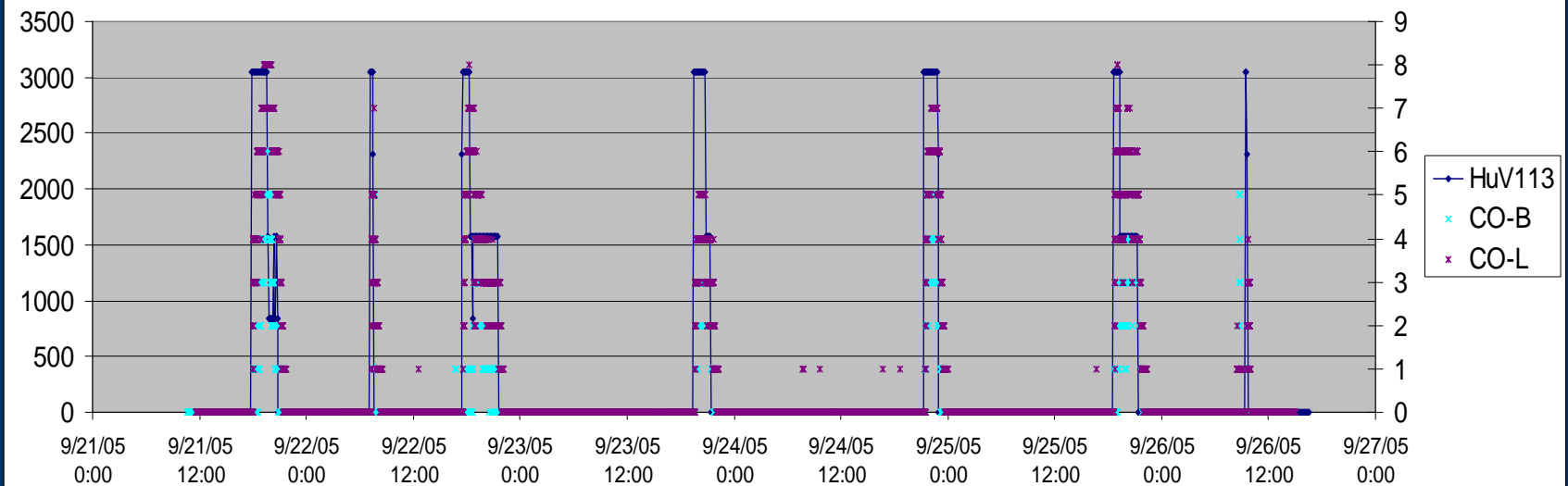
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## CO2



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# Conclusions

- UFGH generated significantly higher concentrations of all indoor chemicals measured than all other types of heaters. Peak values from UFGH for all measured chemicals were in excess of internationally recognised limits, despite these heaters being operated for a shorter period than required to reach a satisfactory temperature.





# Nitrogen dioxide

- Homes heated with UFGH had nitrogen dioxide levels up to five and half times higher than WHO guidelines.
- Emissions occurred simultaneously with the operation of their heater.
- Nitrogen dioxide levels were very low in homes heated with other types of heaters.



# Formaldehyde and carbon monoxide

- The difference between heater types was less apparent for formaldehyde as there are numerous sources of formaldehyde in a home and for carbon monoxide since the levels were generally low for this gas.



# Temperature

- Most homes in the intensive monitoring sub group were **too cold** according to the WHO guidelines, except for a few houses with a heat pump or wood burner and the one home with electric heater that was operated 24h/7days.



# Acknowledgements

