

Comparing Leakage Rates of Methyl Bromide and Sulfuryl Fluoride during Structural Fumigations

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Introduction

- Are MB and SF lost from buildings differently during typical structural fumigations?
- Problem – when gas leakage rates are compared, environmental conditions generally are not analyzed in detail and sealing quality is assumed to be the same

Introduction

- Fumigation experiments were conducted with as many controlled parameters as possible
 - Two MB and two SF fumigations in one single building (i.e., Hal Ross Flour Mill at K-State)
 - Almost identical sealing quality verified by building pressurization tests

Fumigation #	MB1	SF2	MB3	SF4
Starting time	6:40 PM May 6th	6:00 PM May 27th	2:50 PM Aug 11th	2:45 PM Aug 19th
Exposure (hr)	~24	~24	~24	~24

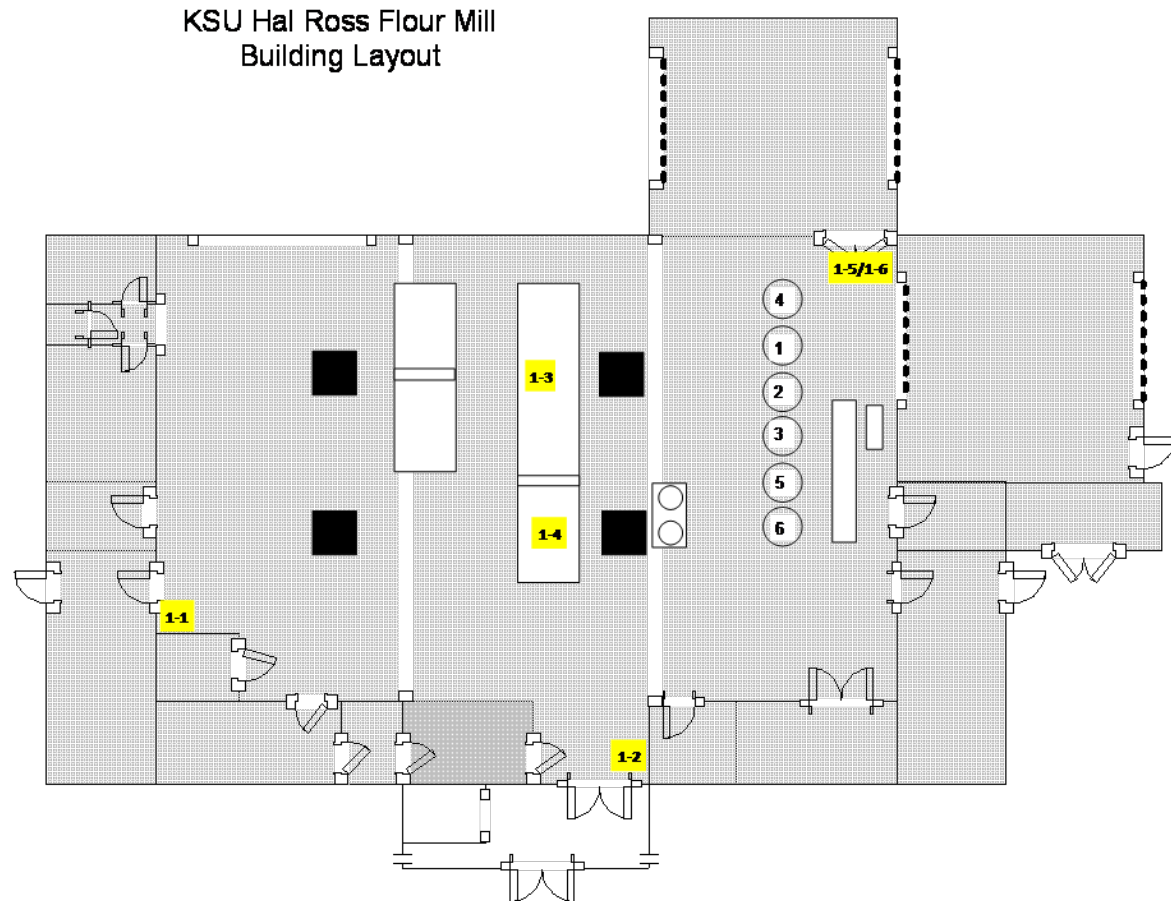
Experimental Setup

- Pressurization test
- Weather station (temperature, RH, wind, solar radiation, barometric pressure)
- Temp/RH logger (one point on each floor)



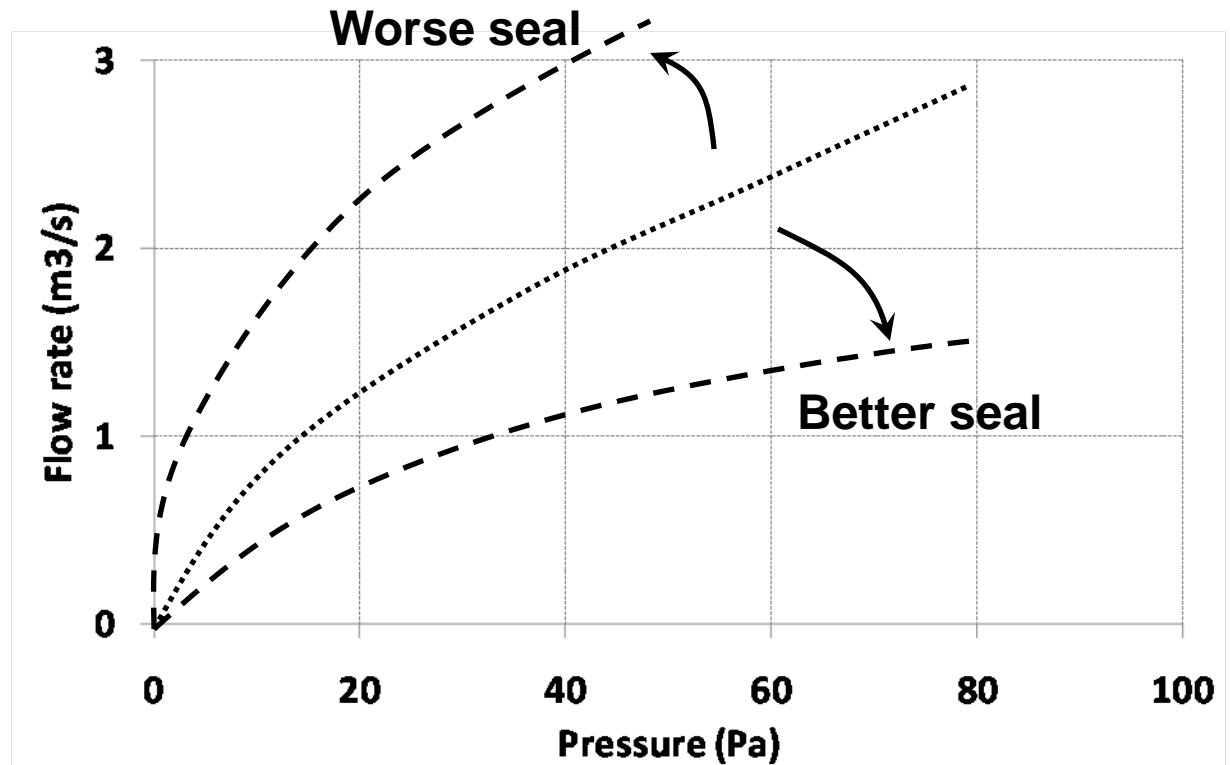
Experimental Setup

- Gas concentrations continuously monitored at 6 locations evenly distributed on each floor



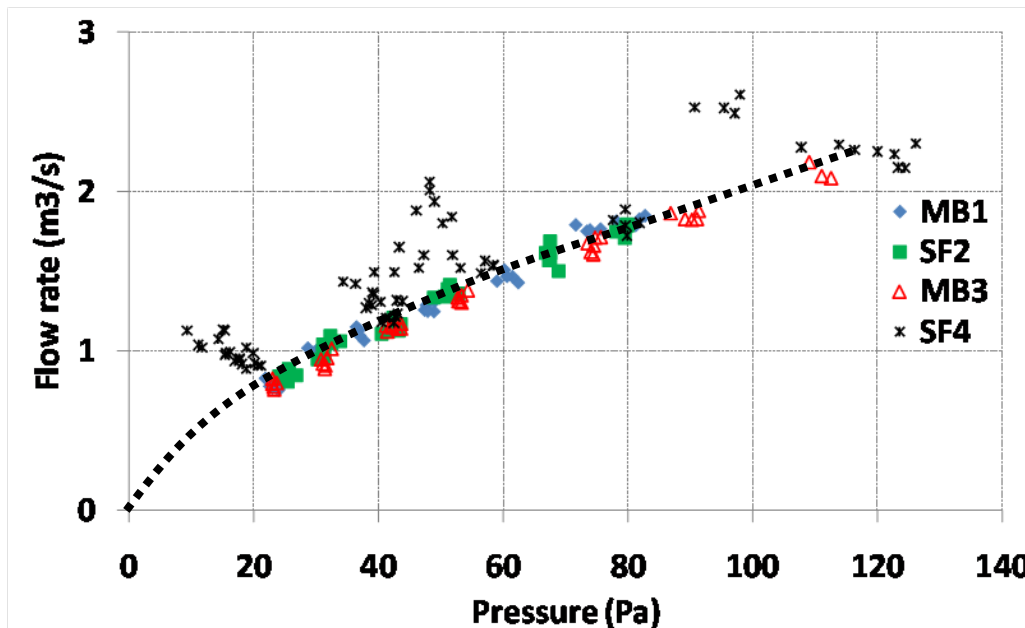
Pressurization Test

- Flow rate VS Pressure
 - Good seal → Lower flow rate at any given pressure

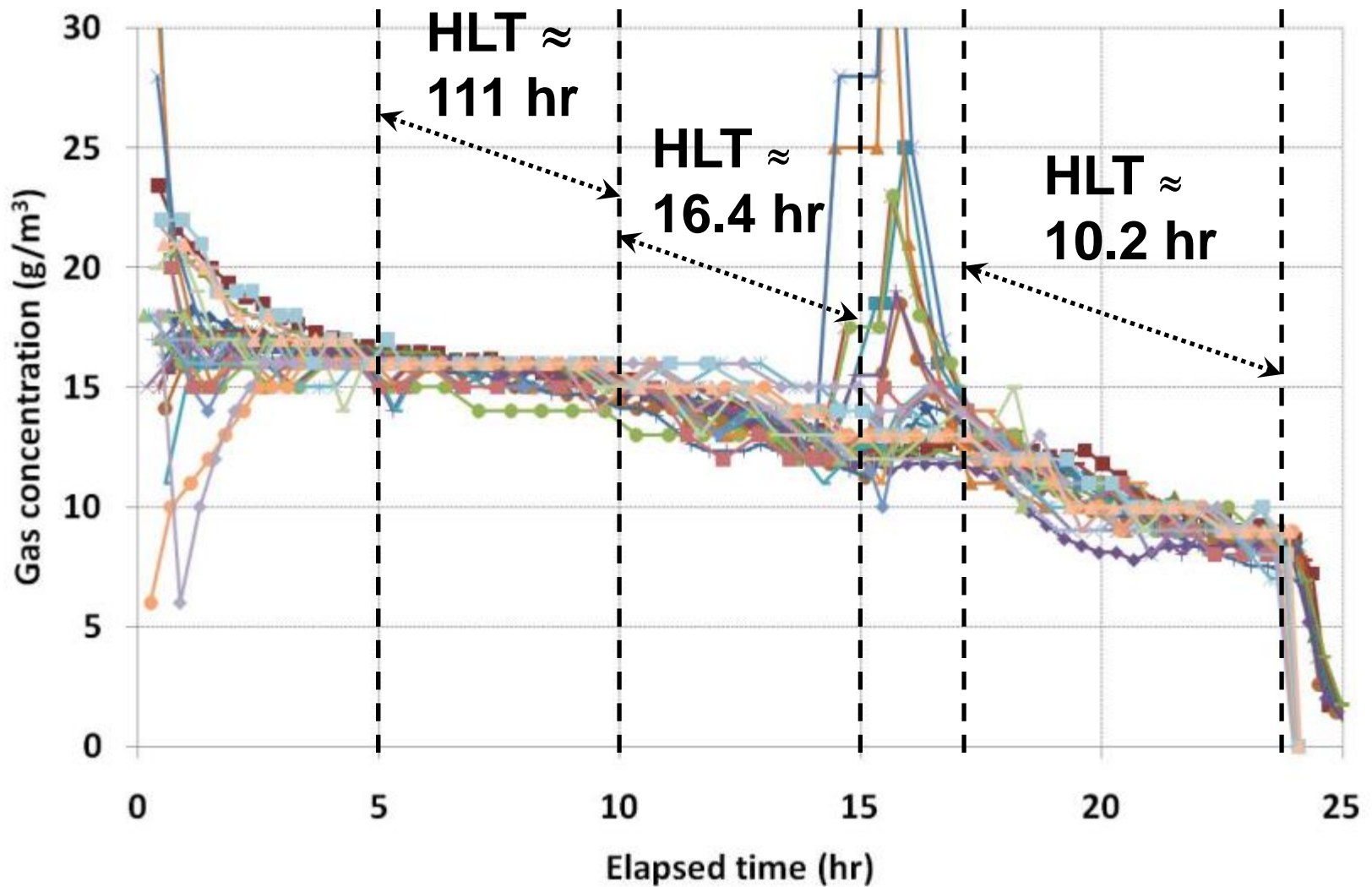


Pressurization Test

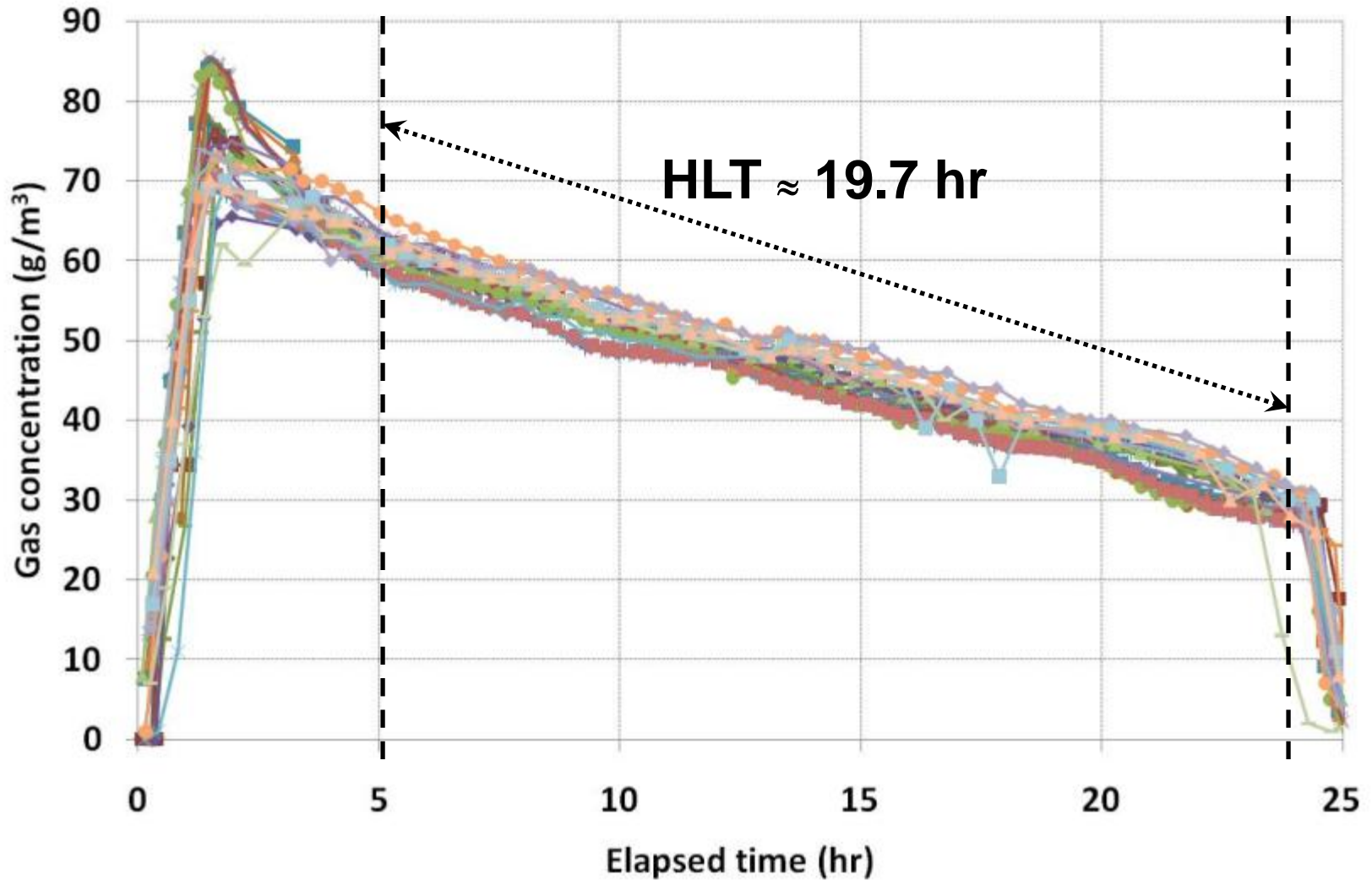
- Sealing quality of MB1, SF2 and MB3 fumigations was identical
 - Pressure test result of SF4 experiment was adversely affected by strong outdoor wind
- Assuming best sealing quality of SF4 experiment, sealing quality of all fumigations was the same



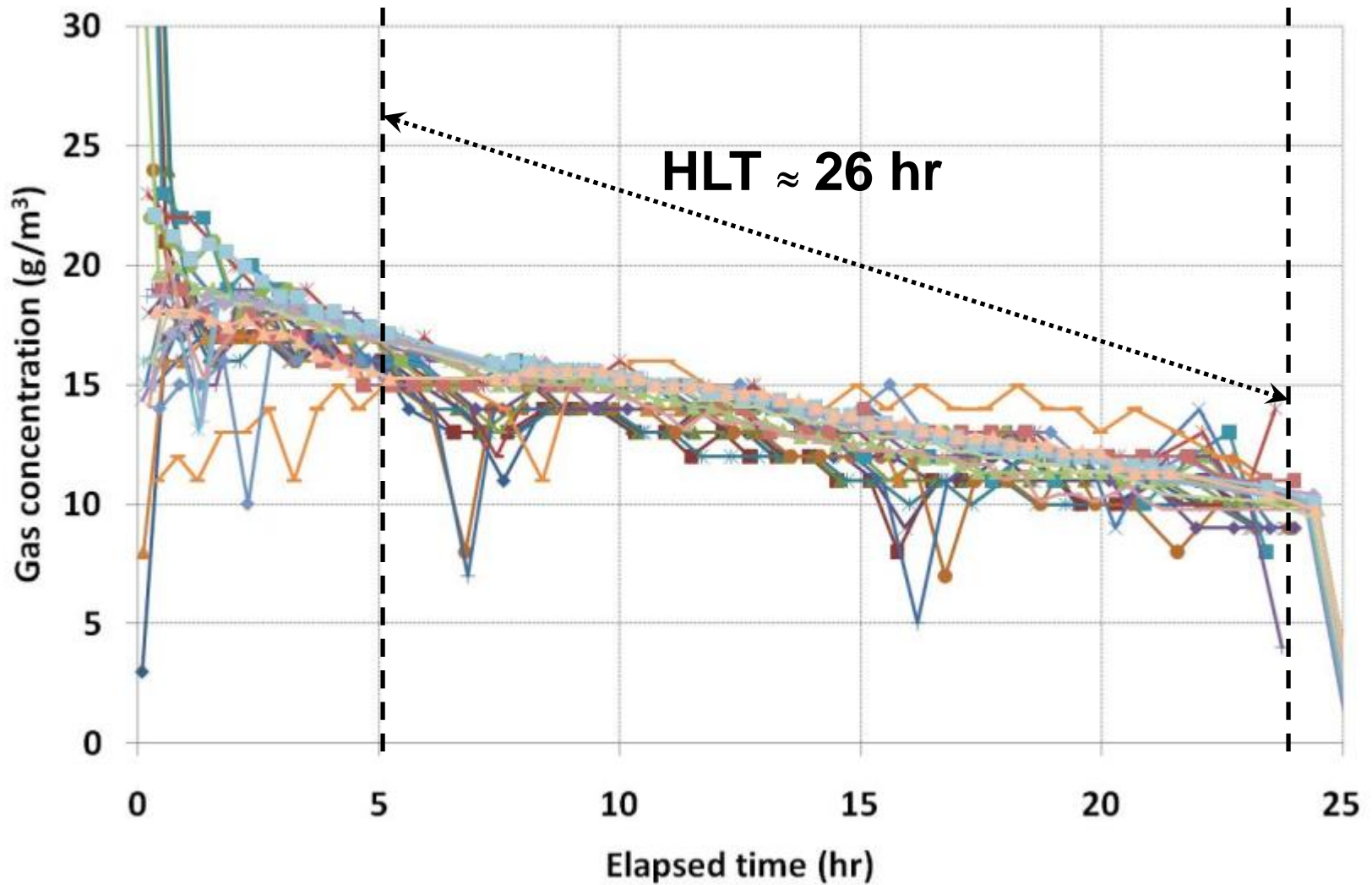
Gas Concentration: MB1



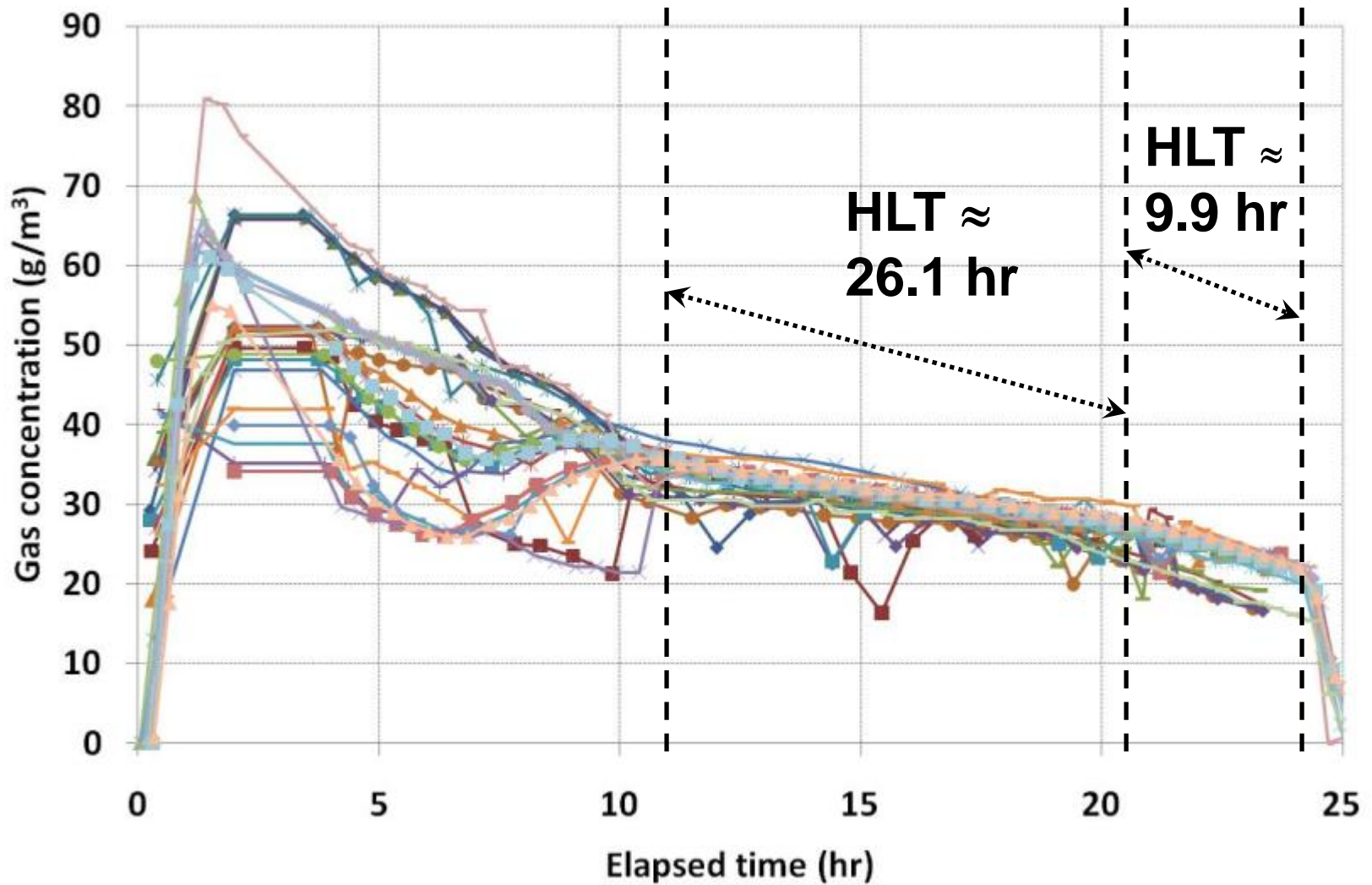
Gas Concentration: SF2



Gas Concentration: MB3



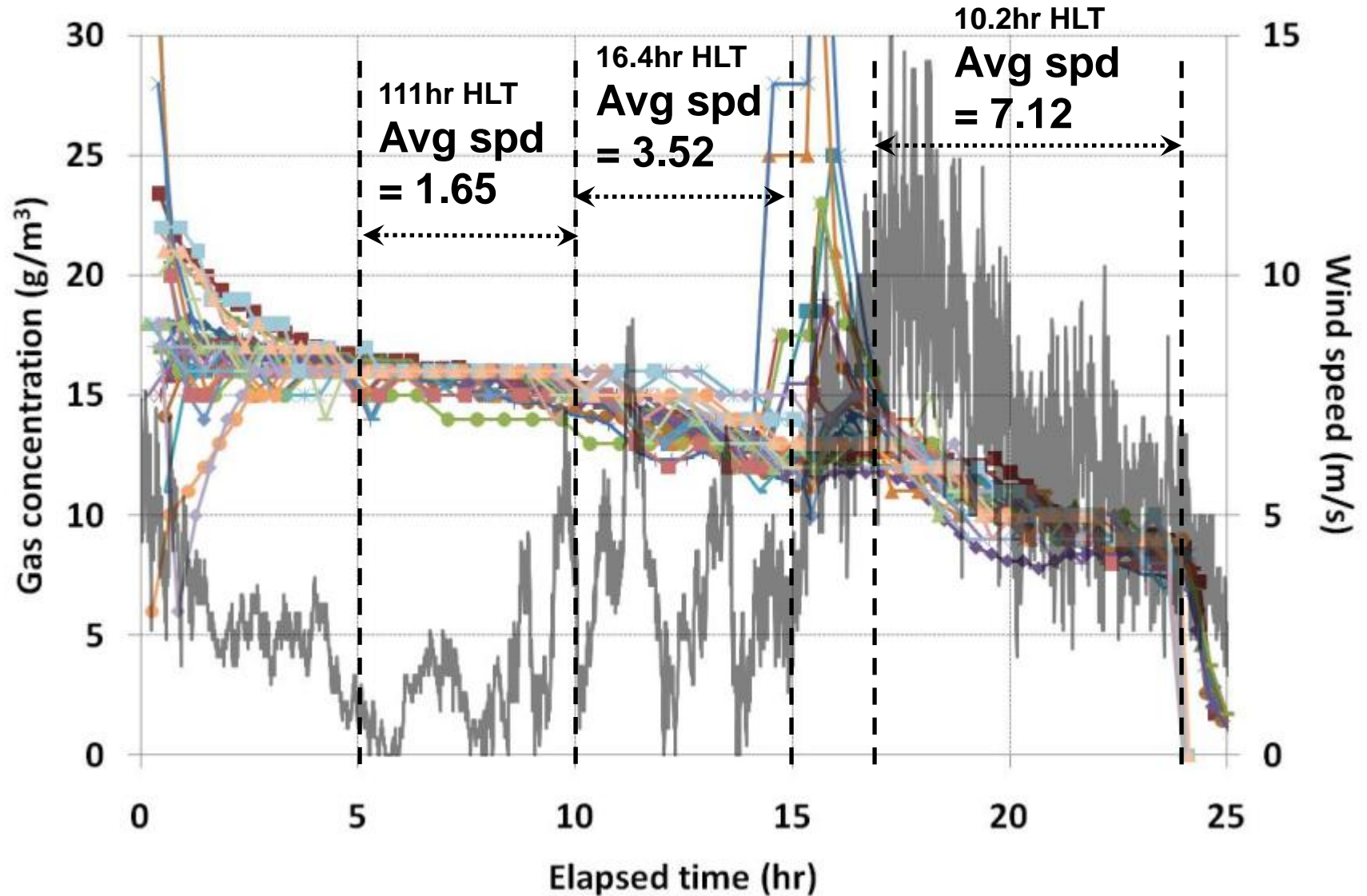
Gas Concentration: SF4



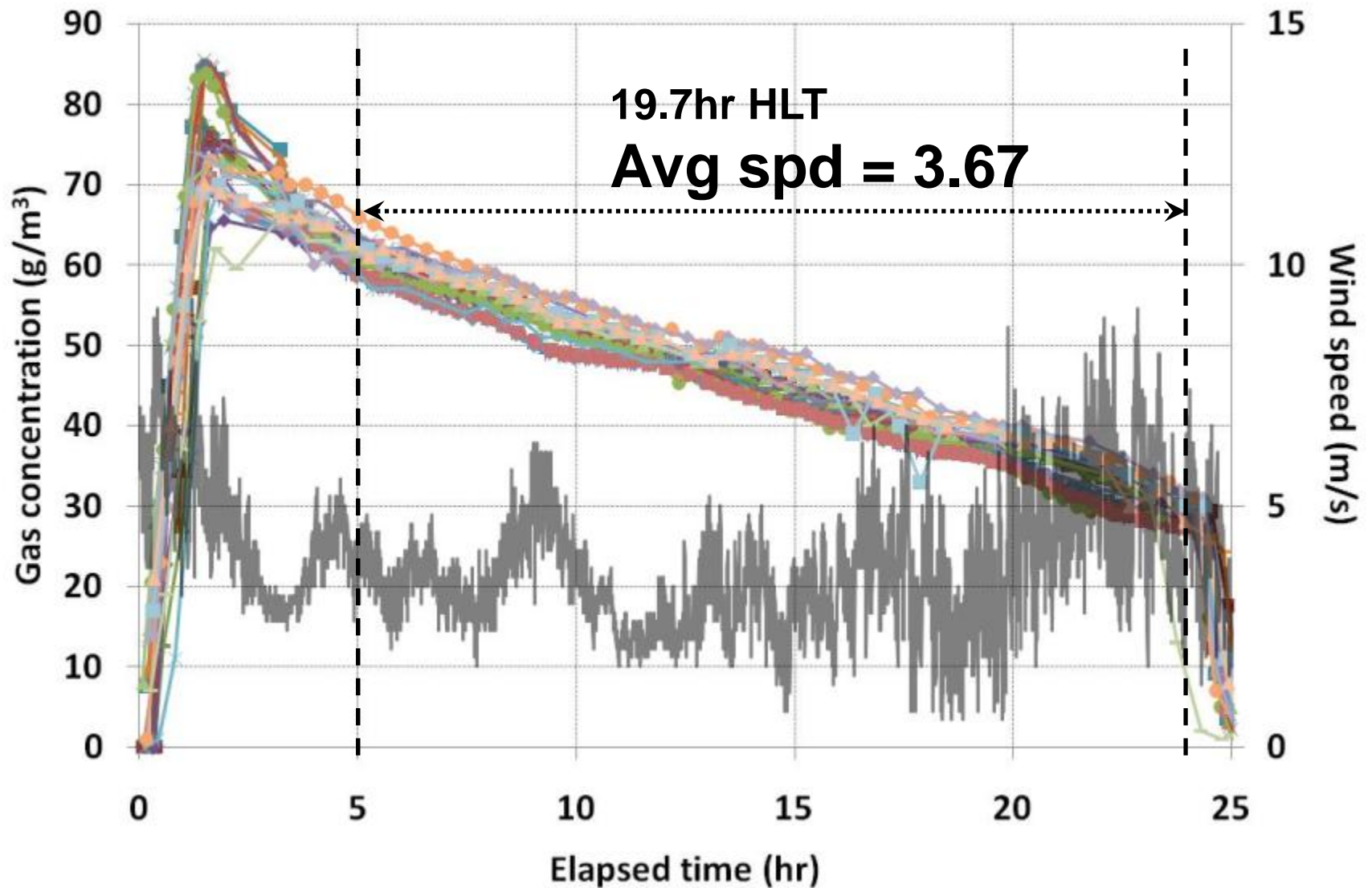
Discussion

- Both MB and SF were evenly distributed throughout the building
 - Both MB and SF fumigations showed varying HLTs
 - Sealing quality was the same, but different HLTs were observed
- What caused these differences?
- Can the weather data explain this?

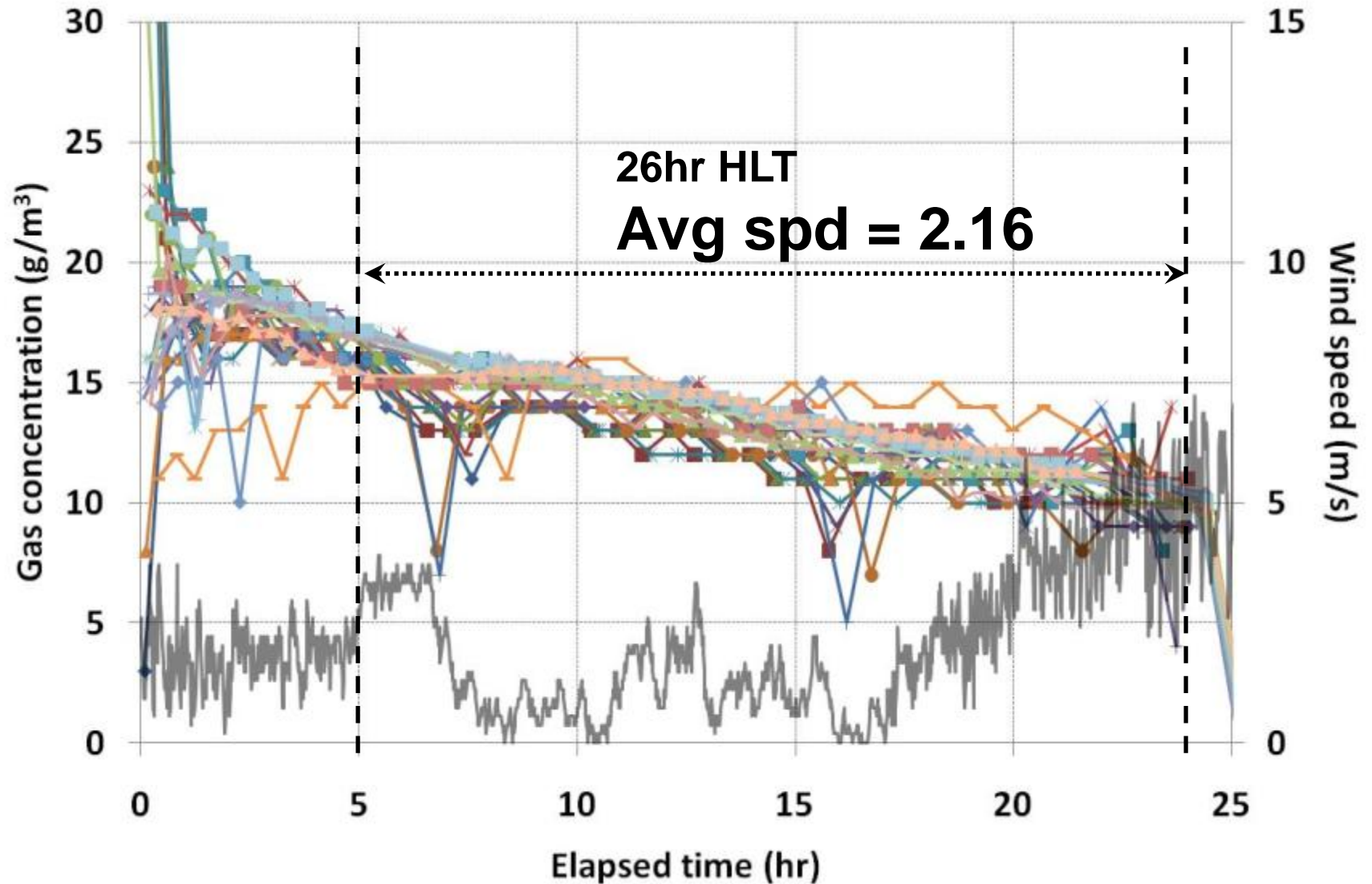
Gas Concentration: MB1



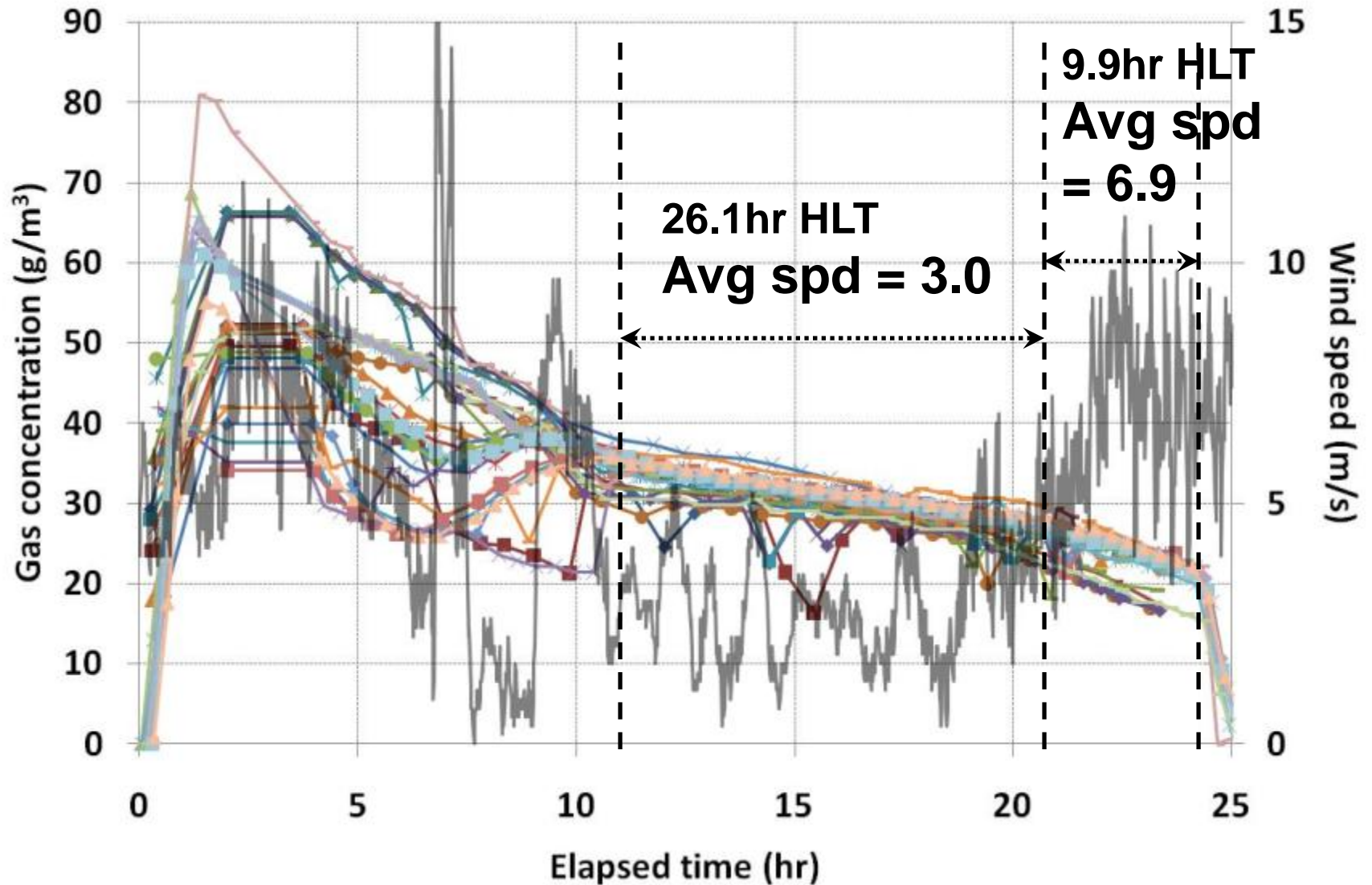
Gas Concentration: SF2



Gas Concentration: MB3



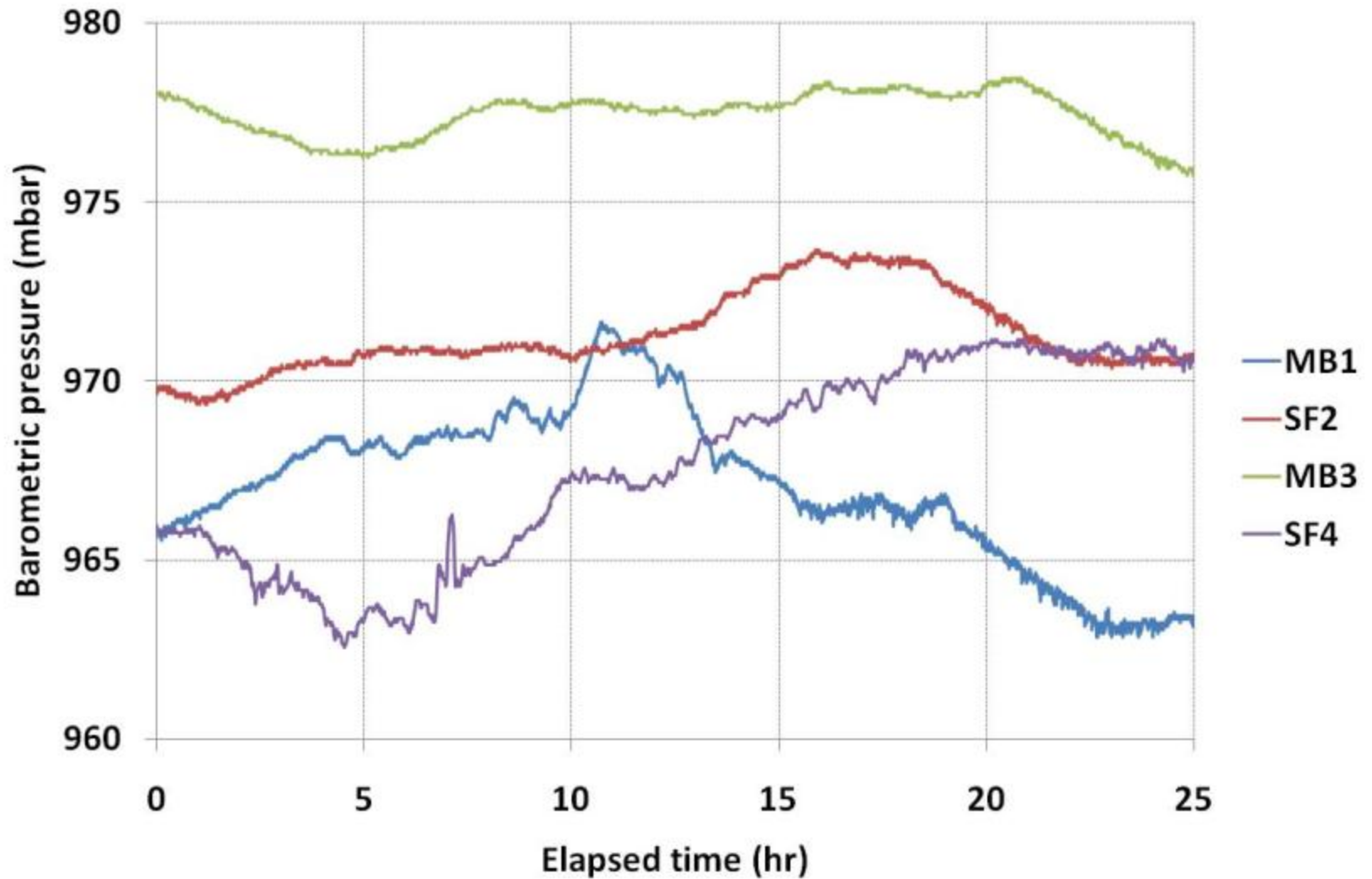
Gas Concentration: SF4



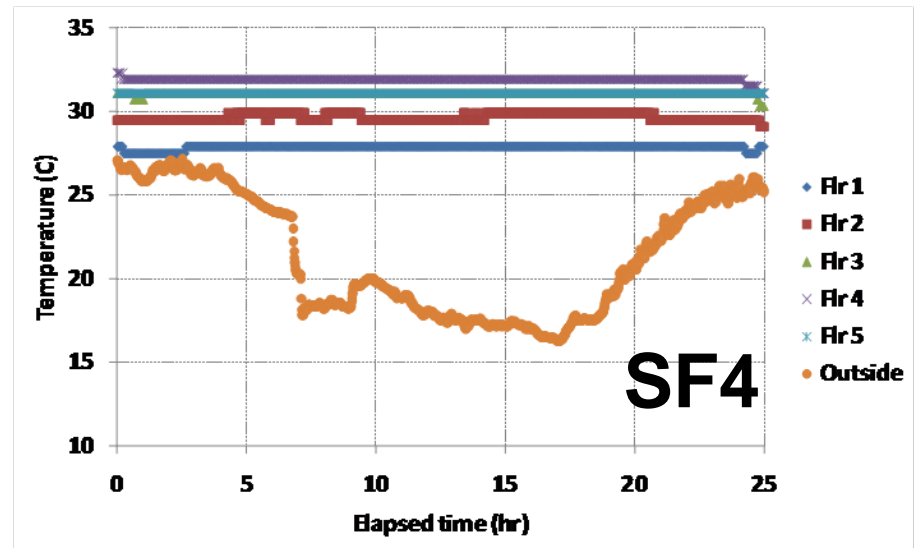
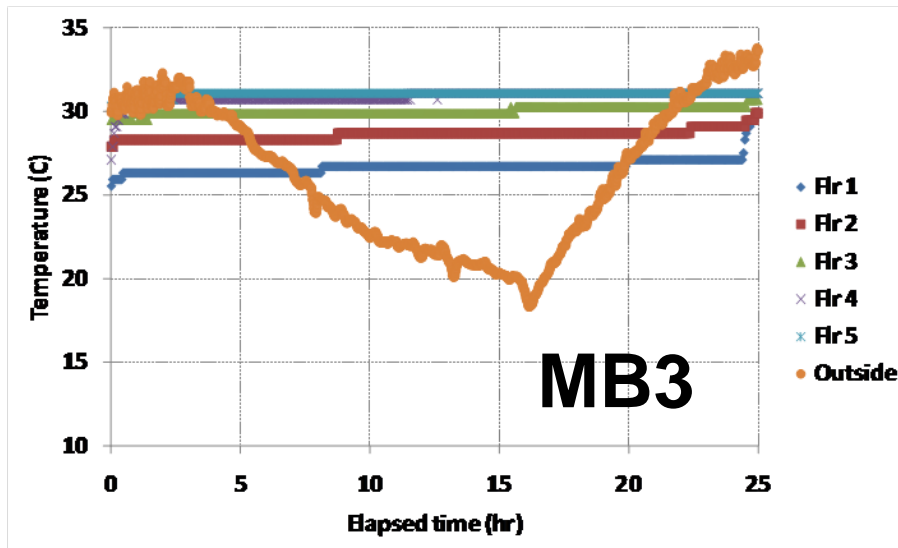
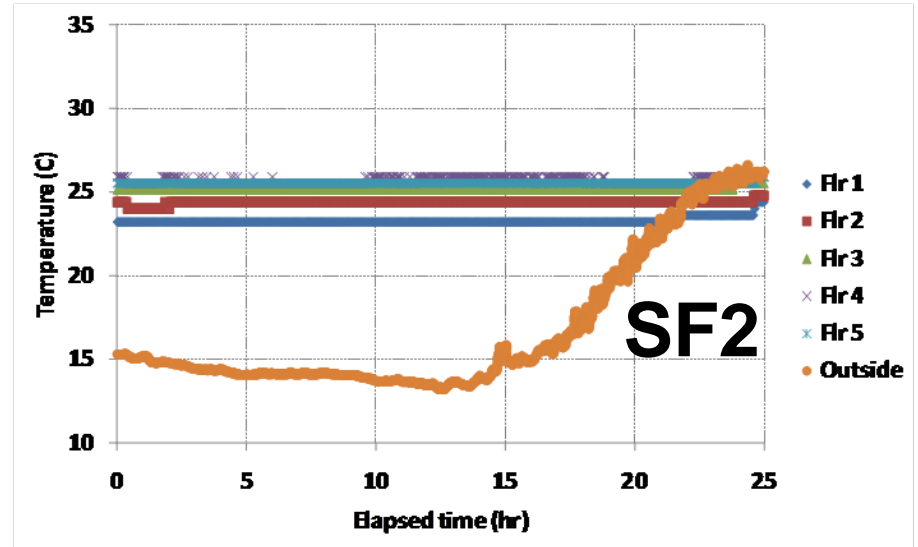
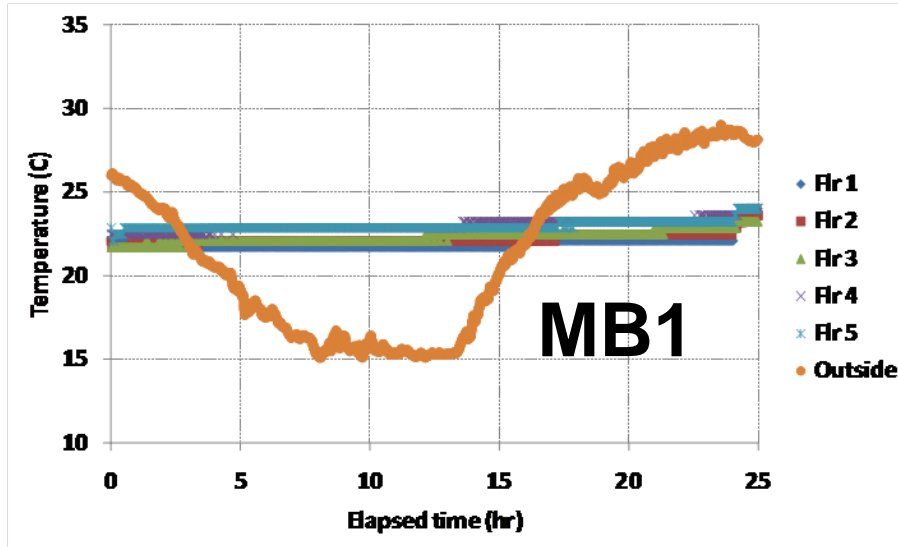
Discussion

- Wind speed data are consistent with the observed HTLs
- Small fluctuations of wind could not be picked up by gas monitoring
- How about buoyancy (i.e., inside-outside temperature differences) and barometric pressure pumping forces?

Barometric Pressure



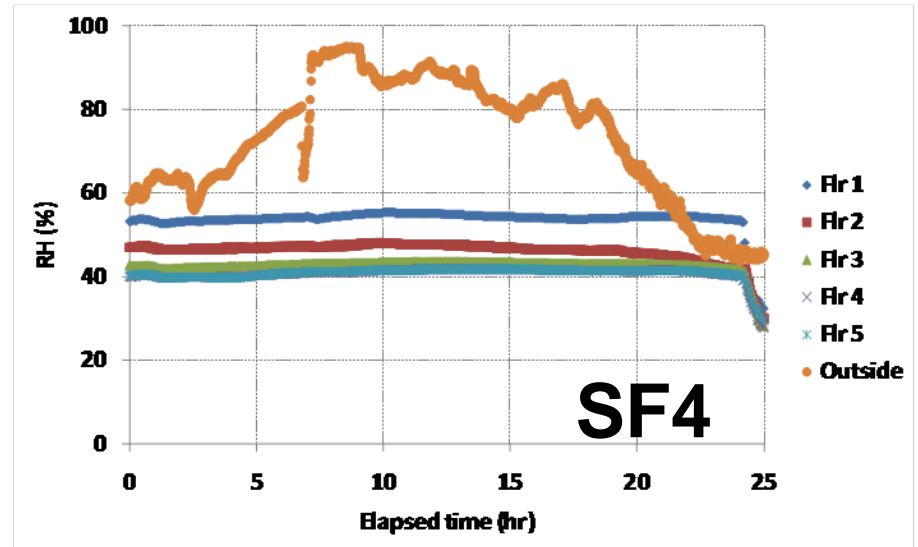
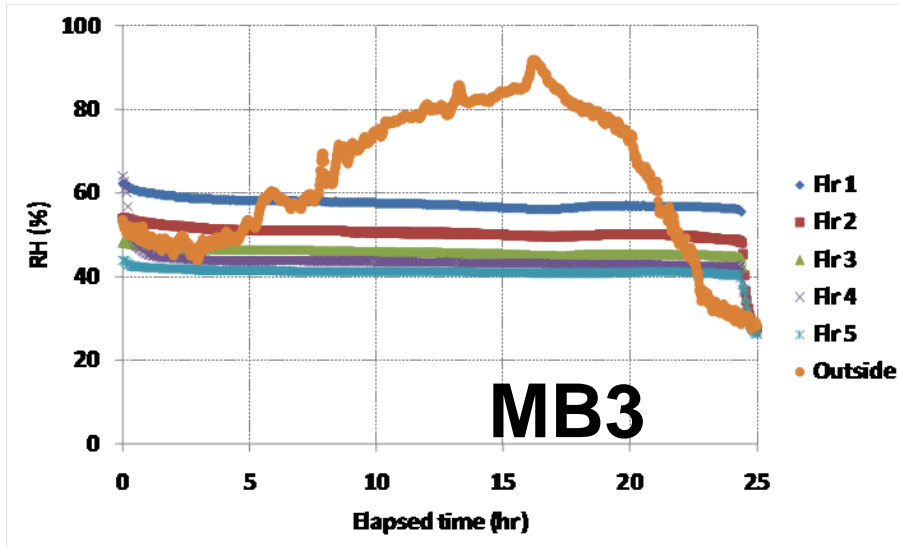
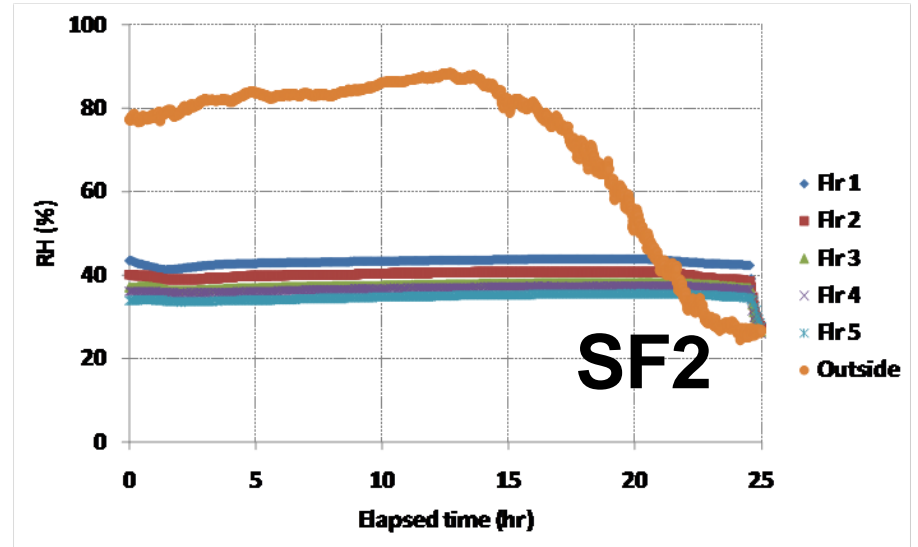
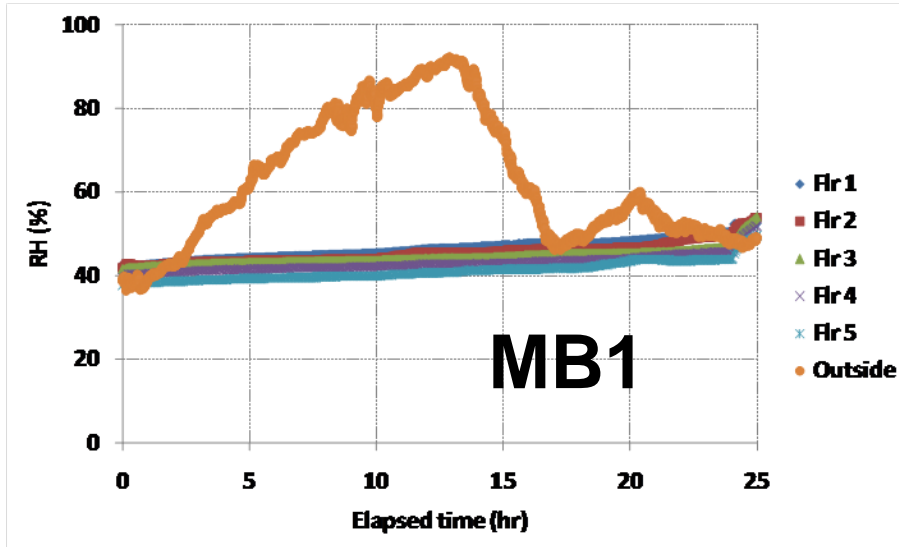
Temperatures



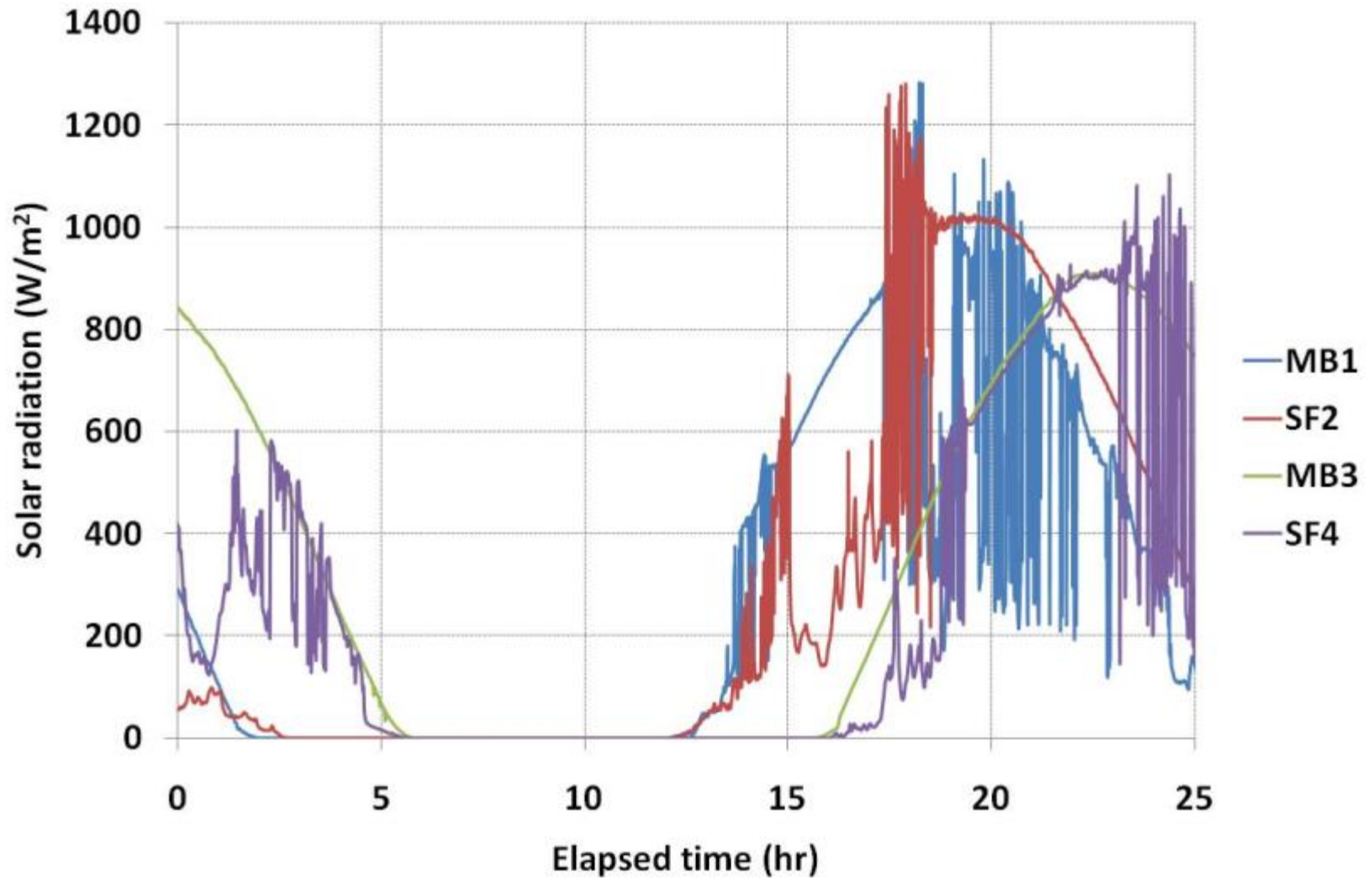
Discussion

- Clear-cut correlations between the buoyancy and pressure pumping forces and the HLTs could not be established
 - Their effects might be overshadowed by the wind effect
 - More data analyses are to be conducted

Relative Humidity



Solar Radiation



Summary of Results

	MB1	SF2	MB3	SF4
Starting time	6:40 PM May 6th	6:00 PM May 27th	2:50 PM Aug 11th	2:45 PM Aug 19th
Exposure (hr)	24	24	24	24
Total gas used (kg)	181 (400 lb)	567 (1250 lb)	159 (350 lb)	511 (1125 lb)
Inside temp (C)	22 - 23	23 - 26	27 - 31	28 - 32
Outside temp (C)	15 - 29	14 - 26	19 - 34	16 - 27
Inside RH (%)	39 - 50	34 - 44	40 - 60	40 - 55
Outside RH (%)	37 - 91	25 - 88	30 - 90	45 - 95
Avg wind spd (m/s)	1.65, 3.52, 7.12	3.67	2.16	3.0, 6.9
HLT (hr)	111, 16.4, 10.2	19.7	26	26.1, 9.9
Ct product (g-hr/m³)	283 - 327	923 - 1191	268 - 318	663 - 1003

Discussion

- Despite variations in outside temperature, RH and solar radiation, the inside temperatures and RHs were relatively stable during the entire exposure periods
 - The building was relatively airtight
 - The heat transfer rate between the inside and outside and the heat generation and accumulation rates within the building were balanced
 - Similar observations can be expected for other buildings with the same airtightness level
- Less MB and SF were used for the August fumigation because of higher inside temperatures

Conclusions

- First head-to-head comparison between MB and SF under nearly identical conditions in the same facility
- SF and MB showed similar gas dynamics (i.e., gas distribution and leakage characteristics)
 - Inside gas distributions were dominated by circulation fans
 - Leakage rates were influenced by environmental conditions
 - For these particular experiments, wind was the dominating factor
- Sealing effectiveness can be determined by pressurization testing ahead of a fumigation
 - It cannot perfectly predict HLT
 - It can differentiate a "well" vs "poorly" sealed facility

Thank You

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