HOUSE PRESSURE TEST--RETURN BLOCKED VS. SUPPLY BLOCKED conf 5

1	FAN ON House-Attic ΔP	0.5	0.6	0.8	1.1	0.8	Avg: 0.71
		0.7	1.0	0.8	0.4	0.4	
2	FAN OFF House-Attic ΔP	1.5	1.1	1.1	1.0	1.3	Avg: 1.49
		1.6	2.2	2.0	1.8	1.3	
3	FAN ON House-Attic ΔP	1.2	0.8	0.8	1.0	0.6	Avg: 0.70
		0.4	0.2	0.4	0.8	0.8	
4	Return-House ΔP	reg.	p1 -1.4	p2 -2.2	p3 -3.6	p4	plm -7.8
5	Pressure Pan ΔP	s1 40	s2 21	s3 18	s4 24	s5 17	s6 25
6	FAN OFF House-Attic ΔP	1.2	1.2	1.8	1.9	1.3	Avg: 1.40
		0.6	1.0	1.5	1.8	1.7	
RETN BLCK	7 FAN ON-RETN BLOCKED Return-House ΔP	reg.	p1 -37	p2 -38	p3 -41	p4	plm -44
	8House-Attic ΔP	2.5	1.7	2.0	2.0	2.6	Avg: 1.85
		1.8	1.6	1.5	1.5	1.3	
	9Pressure Pan ΔP	s1 42	s2 20	s3 18	s4 24	s5 17	s6 24
SUPP BLCK	10FAN ON-SUPP BLOCKED Return-House ΔP	reg.	p1 -1.3	p2 -2.3	p3 -4.4	p4	plm -7.5
	11House-Attic ΔP	1.0	1.6	0.7	1.0	1.1	Avg: 1.03
		1.0	1.1	1.1	0.9	0.8	
	12Pressure Pan ΔP	s1 107	s2 81	s3 70	s4 92	s5 60	s6 84
13	FAN OFF House-Attic ΔP	1.2	0.9	1.5	1.0	2.1	Avg: 1.17
		1.8	1.5	0.8	0.6	0.3	
14	Blower Door		CFM @		Pa		

BR1 21
BR2 19
BR3 20

BR1 20
BR2 18
BR3 20

BR1 90
BR2 80
BR3 83

Stopped - getting windy

HOUSE PRESSURE TEST--RETURN BLOCKED VS. SUPPLY BLOCKED cont's

next day - calmer

1	FAN ON House-Attic ΔP	0	0	0	0	0,1	Avg:
		-0,2	0	0,3	0,4	0,5	0.11
2	FAN OFF House-Attic ΔP	0,1	0,3	0,2	0,2	0,2	Avg:
		0,2	0	0	0	0,1	0,13
3	FAN ON House-Attic ΔP	0,8	0,5	0,6	0,5	0,3	Avg:
		0,1	0	0	-0,2	-0,2	0.24
4	Return-House ΔP	reg.	p1 -1,2	p2 -2,2	p3 -4,9	p4	plm -7,5
5	Pressure Pan ΔP	s1 39	s2 19	s3 17,5	s4 22,5	s5 16	s6 23
6	FAN OFF House-Attic ΔP	0,2	0,2	0,3	0,2	0,2	Avg:
		0	0	0	0	0,1	0,12
RETN BLOCK	7 FAN ON-RETN BLOCKED Return-House ΔP	reg.	p1 -38	p2 -38,5	p3 -42	p4	plm -43,5
	8House-Attic ΔP	1,7	1,3	1,0	1,3	1,0	Avg:
		0,8	1,1	0,9	0,9	1,4	1,14
	9Pressure Pan ΔP	s1 41	s2 20	s3 17	s4 22	s5 16	s6 23
SUPP BLOCK	10FAN ON-SUPP BLOCKED Return-House ΔP	reg.	p1 -1,3	p2 -2,3	p3 -5	p4	plm -7,5
	11House-Attic ΔP	-0,5	-0,7	-0,5	-0,4	-0,5	Avg.
		-0,5	-0,4	-0,2	0,2	0,3	-0,32
	12Pressure Pan ΔP	s1 106	s2 80	s3 71	s4 95	s5 59	s6 77
13	FAN OFF House-Attic ΔP	0	0	0	0,1	0,2	Avg:
		0	0	-0,1	-0,5	-0,1	-0,04
14	Blower Door		CFM @		Pa		

19
18,5
20
19
18,5
20
87
82
75

Other Diagnostic Tests

This section presents miscellaneous measurements of gas flow rate, steady state furnace efficiency, coheating power, register flow, and furnace fan flow in chronological order.

November 18

Gas flow rate: Three measurements were taken over firing periods of between 10 and 11 minutes, yielding flow rates of 0.037424 ft^3/min, 0.037481 ft^3/min, and 0.037415 ft^3/min.

SSE: Four measurements were taken from four consecutive normal cycles, yielding values of 83%, 81.5%, 82%, and 82.5%. The average of 82.25% was used for configuration 1.

January 11

Coheating power: Measurements of coheater kVA were taken using both the coheater controller and the house's electrical meter. For a controller measurement of 11.45 kVA, the house meter measured 11.82 kVA. For a controller measurement of 6.70 kVA, the house meter measured 6.77 kVA.

Register flows: Supply register flows were measured with the duct pressurization fan, yielding:

Reg.	Ring	Fan Pa	Fan CFM
S-1	2	95	149
S-2	2	43	100
S-3	2	137	180
S-4	2	35	90
S-5	-	-	-
S-6	3	135	72
S-7	3	170	82
S-8	3	170	82
S-9	3	311	110
Total			>865

January 17

SSE: Four measurements were taken from four consecutive normal cycles, yielding values of 82%, 81.5%, 81.5%, and 83%. The average of 82% was used for configuration 2.

Gas flow rate: Two measurements were taken over firing periods of between 10 and 11 minutes, yielding flow rates of 0.037422 ft^3/min and 0.037482 ft^3/min.

January 20

Furnace Fan Flow: Fan flow was checked with a hot wire anemometer traverse of the return plenum at mid-height, yielding a measurement of 712 CFM.

February 12

SSE: Four measurements were taken from four consecutive normal cycles, yielding values of 80%, 81.5%, 82%, and 80.5%. The average of 81% was used for configuration 3.

Gas flow rate: Two measurements were taken over firing periods of between 10 and 11 minutes, yielding flow rates of 0.037234 ft^3/min and 0.03708 ft^3/min.

February 16

Register flows: Supply and return register flows were measured with the duct pressurization fan, yielding:

Reg.	Ring	Fan Pa	Fan CFM
S-1	3	504	141
S-2	3	184	85
S-3	3	494	139
S-4	3	126	70
S-5	-	-	-
S-6	3	69	52
S-7	3	120	69
S-8	3	124	70
S-9	3	247	98
Total			>724
R-1	1	129	446
R-2	2	298	264
R-3	3	93	60
Total			770

March 2

SSE: Four measurements were taken from four consecutive normal cycles, yielding values of 82.5%, 82%, 83%, and 84%. The average of 83% was used for configuration 4.

Gas flow rate: Two measurements were taken over firing periods of between 10 and 11 minutes, yielding flow rates of 0.037662 ft^3/min and 0.037684 ft^3/min.

April 2

SSE: Four measurements were taken from four consecutive normal cycles, yielding values of 80.5%, 80.5%, 81%, and 82%. The average of 81% was used for configuration 5.

Gas flow rate: Two measurements were taken over firing periods of between 10 and 11 minutes, yielding flow rates of 0.037284 ft^3/min and 0.037666 ft^3/min.

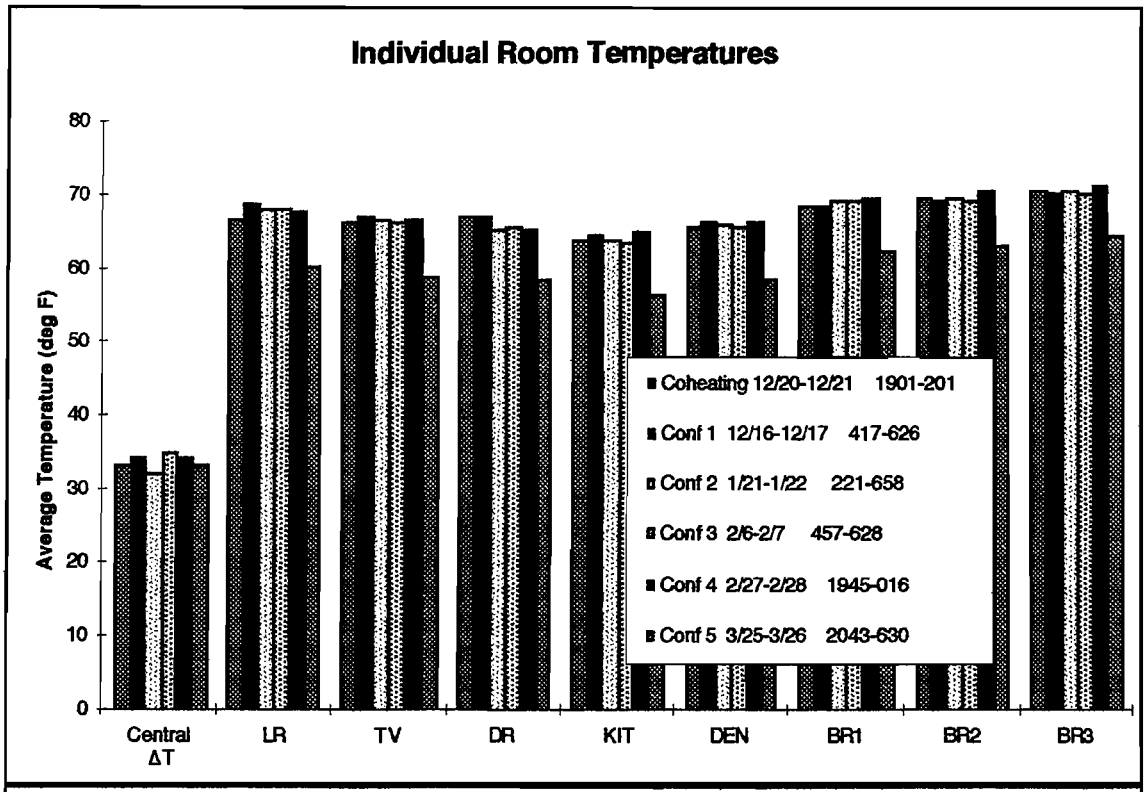
Temperature Sensor Calibration

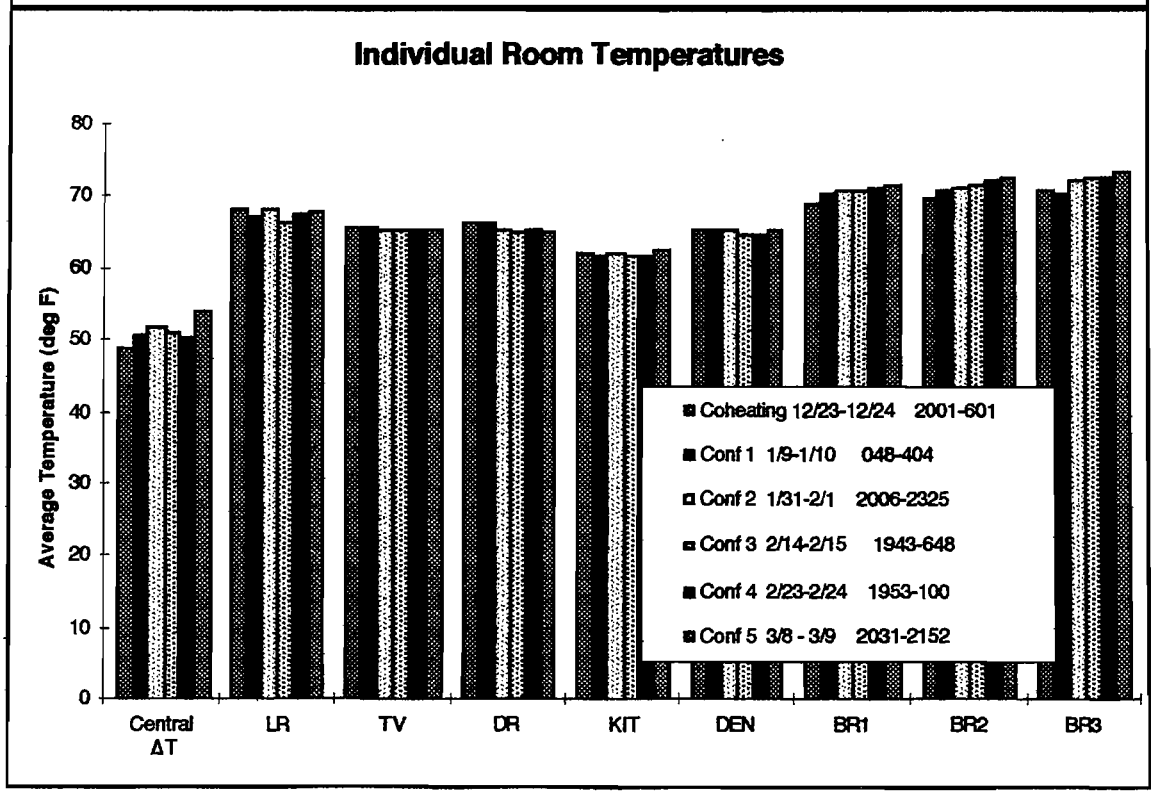
All conditioned space temperature sensors were calibrated using a two-part protocol. Firstly, each sensor was calibrated to 32.0 deg F using an ice-water bath. The following steps were employed:

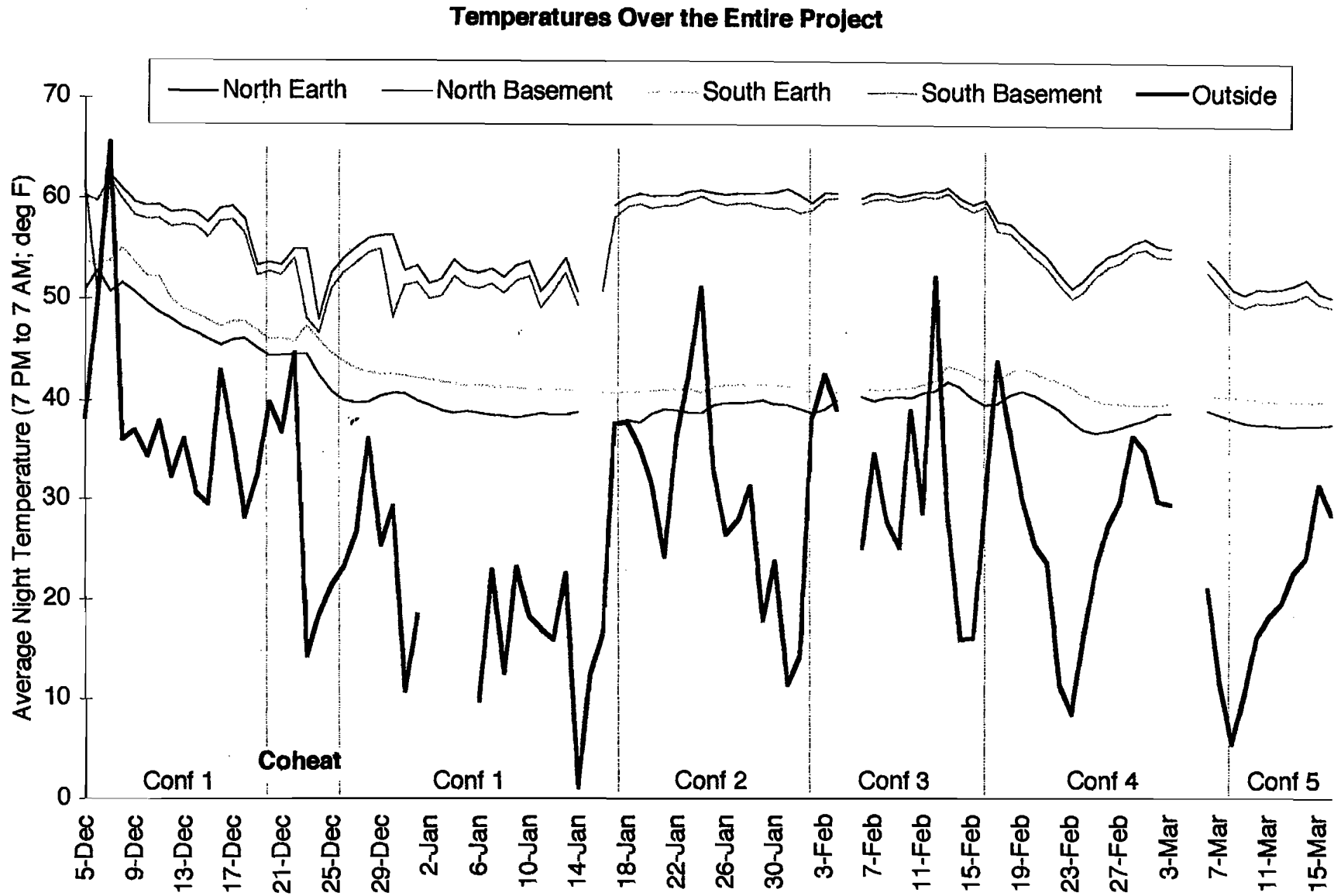
1. Fill a 10-ounce thermos with water and ice; let sit for three hours;
2. Add or remove ice as necessary, such that the lower inch of depth is all water;
3. Wrap a sensor tightly in the corner of a plastic sandwich bag;
4. Use the wrapped sensor to stir the ice-water bath continuously until the measured temperature does not decrease for 60 seconds (typically ~5 minutes);
5. Quickly position the wrapped sensor just off the bottom of the thermos but below the ice;
6. Subtract the average measured temperature over the next 15 seconds from 32.0 deg F, and apply the result to the sensor's intercept value.

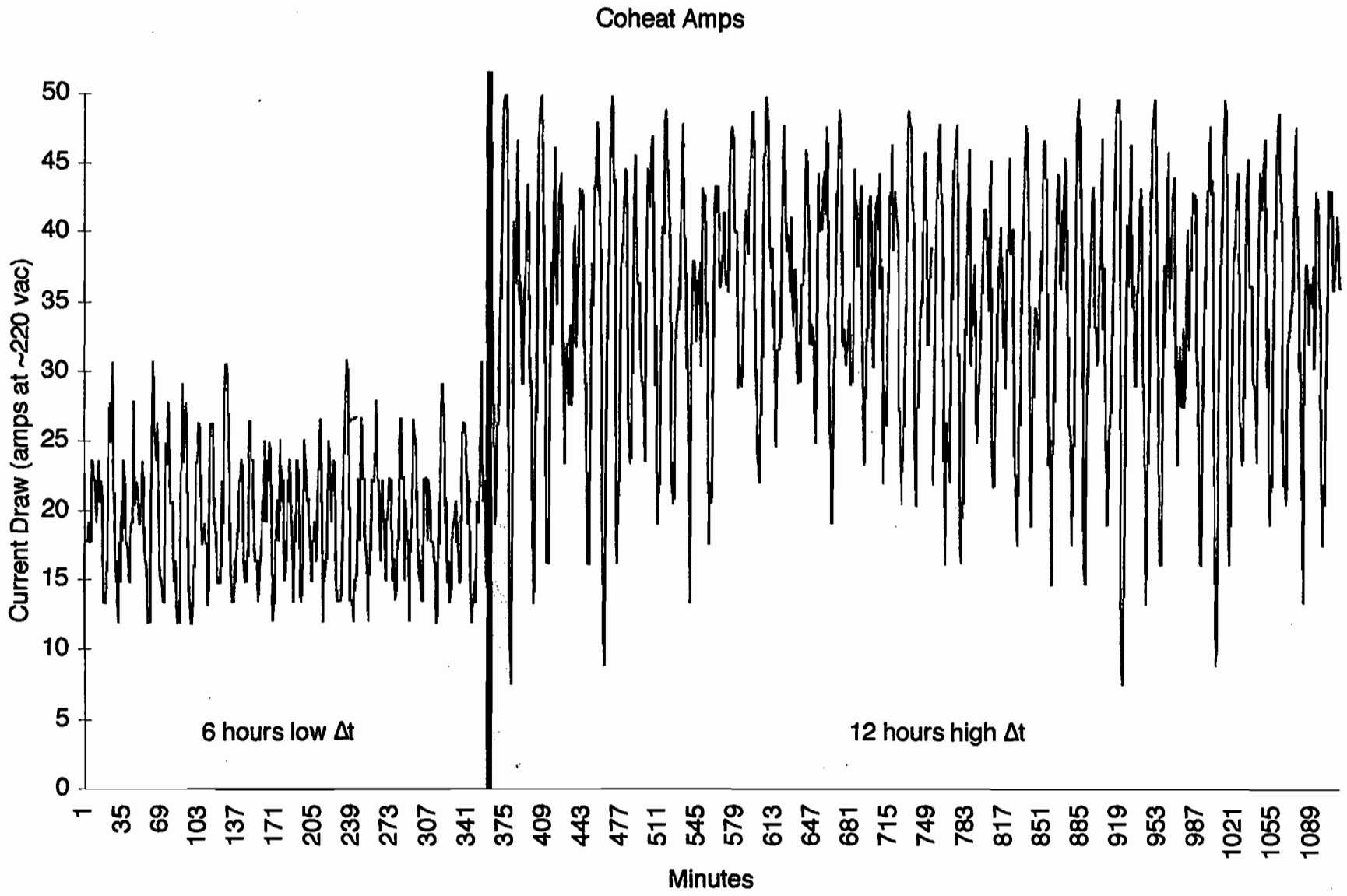
Once all sensors were calibrated to 32.0 deg F the first time, the entire procedure was conducted again the next day to assess repeatability. Two sensors were discarded due to dissimilar results the second day. Once all sensors had passed two ice-water bath tests, they were placed close together inside a sandwich bag and the enclosed bundle was left in a standard camping cooler for 12 hours inside the house. Of the 11 sensors in the 60 to 70 deg F cooler, nine occupied a band less than 0.8 degree in breadth, while two others measured one and six degrees off the band's average. The intercepts of these two sensors were subsequently adjusted again to make their output value correlate with the near edge of the band. All other nine intercepts were allowed to stand without further adjustment.

The two outside air temperature sensors, as well as the basement sensors, went through the two-day ice bath sequence, but were not subjected to the cooler test. However, each of these locations featured a pair of sensors, allowing each to check the other. The ground temperature sensors were also paired, in each of the two locations, but were not calibrated at all.


Individual Room Temperatures
Average Temperature (deg F)
80
70
60
50
40
30
20
10
0
Central ΔT
LR
TV
DR
KIT
DEN
BR1
BR2
BR3
Coheating 12/20-12/21 1901-201
Conf 1 12/16-12/17 417-626
Conf 2 1/21-1/22 221-658
Conf 3 2/6-2/7 457-628
Conf 4 2/27-2/28 1945-016
Conf 5 3/25-3/26 2043-630


Individual Room Temperatures
Average Temperature (deg F)
80
70
60
50
40
30
20
10
0
Central ΔT
LR
TV
DR
KIT
DEN
BR1
BR2
BR3
Coheating 12/23-12/24 2001-601
Conf 1 1/9-1/10 048-404
Conf 2 1/31-2/1 2006-2325
Conf 3 2/14-2/15 1943-648
Conf 4 2/23-2/24 1953-100
Conf 5 3/8 - 3/9 2031-2152


Temperatures Over the Entire Project
North Earth
North Basement
South Earth
South Basement
Outside
Average Night Temperature (7 PM to 7 AM; deg F)
70
60
50
40
30
20
10
0
Coheat
Conf 1
Conf 1
Conf 2
Conf 3
Conf 4
Conf 5
5-Dec
9-Dec
13-Dec
17-Dec
21-Dec
25-Dec
29-Dec
2-Jan
6-Jan
10-Jan
14-Jan
18-Jan
22-Jan
26-Jan
30-Jan
3-Feb
7-Feb
11-Feb
15-Feb
19-Feb
23-Feb
27-Feb
3-Mar
7-Mar
11-Mar
15-Mar

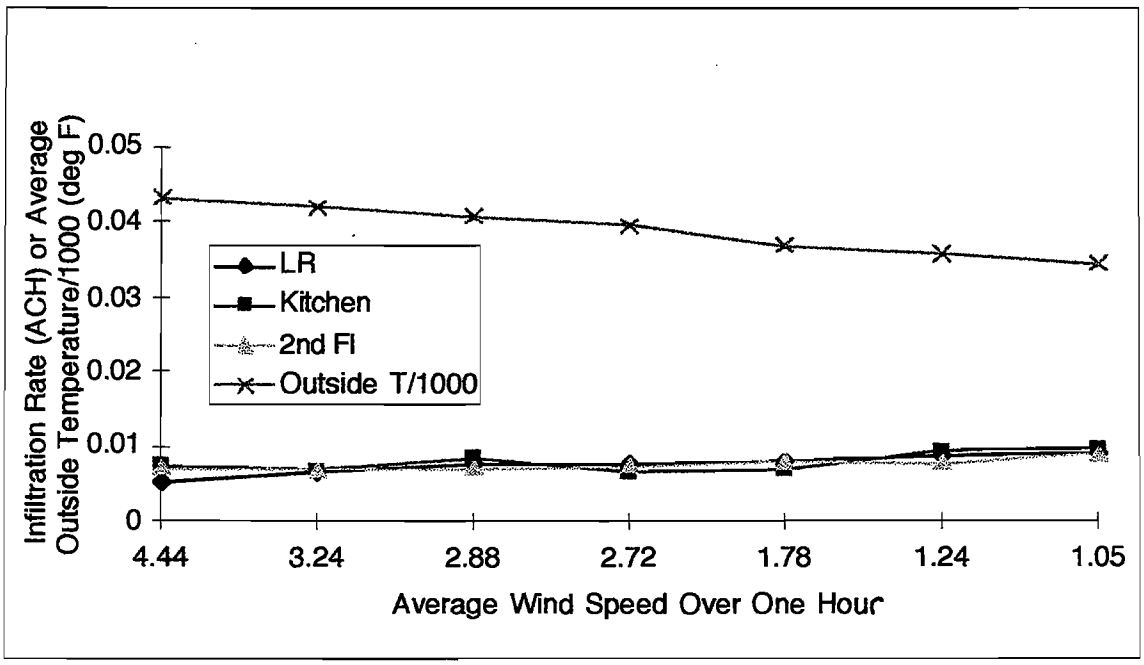

Coheat Amps
Current Draw (amps at ~220 vac)
50
45
40
35
30
25
20
15
10
5
0
6 hours low Δt
12 hours high Δt
1
35
69
103
137
171
205
239
273
307
341
375
409
443
477
511
545
579
613
647
681
715
749
783
817
851
885
919
953
987
1021
1055
1089
Minutes

Sensitivity of Infiltration to Wind Speed

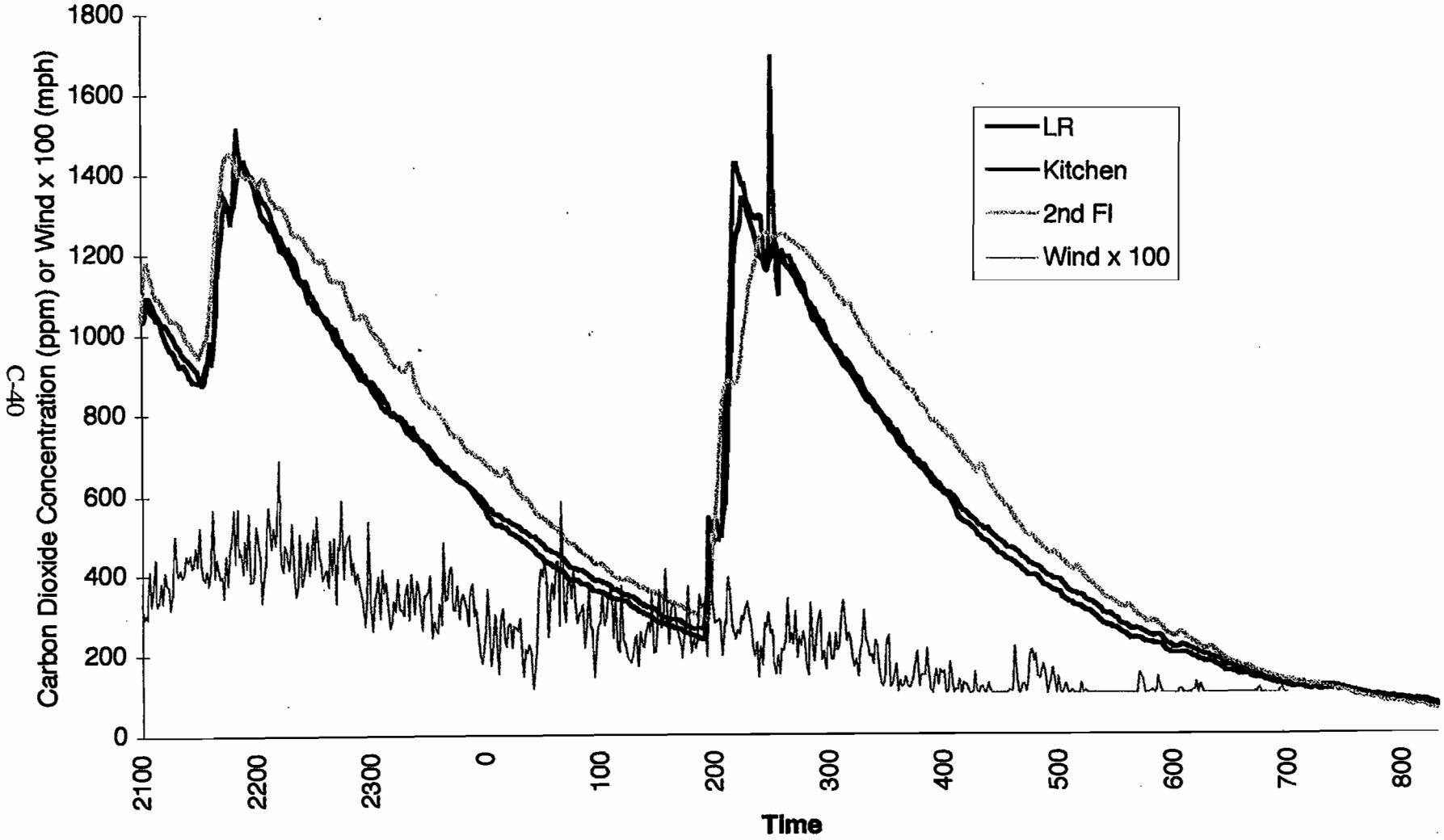
The sensitivity of the infiltration rate to wind speed was examined using a night's worth of tracer gas decay testing. Six separate 60-minute time periods, and one 53-minute period, included average wind speeds from 1.05 mph to 4.44 mph. The objective was to reveal any flaw in the project's assumption that all data records collected and analyzed at wind speeds of less than 1.5 mph would have very similar wind-driven infiltration components.

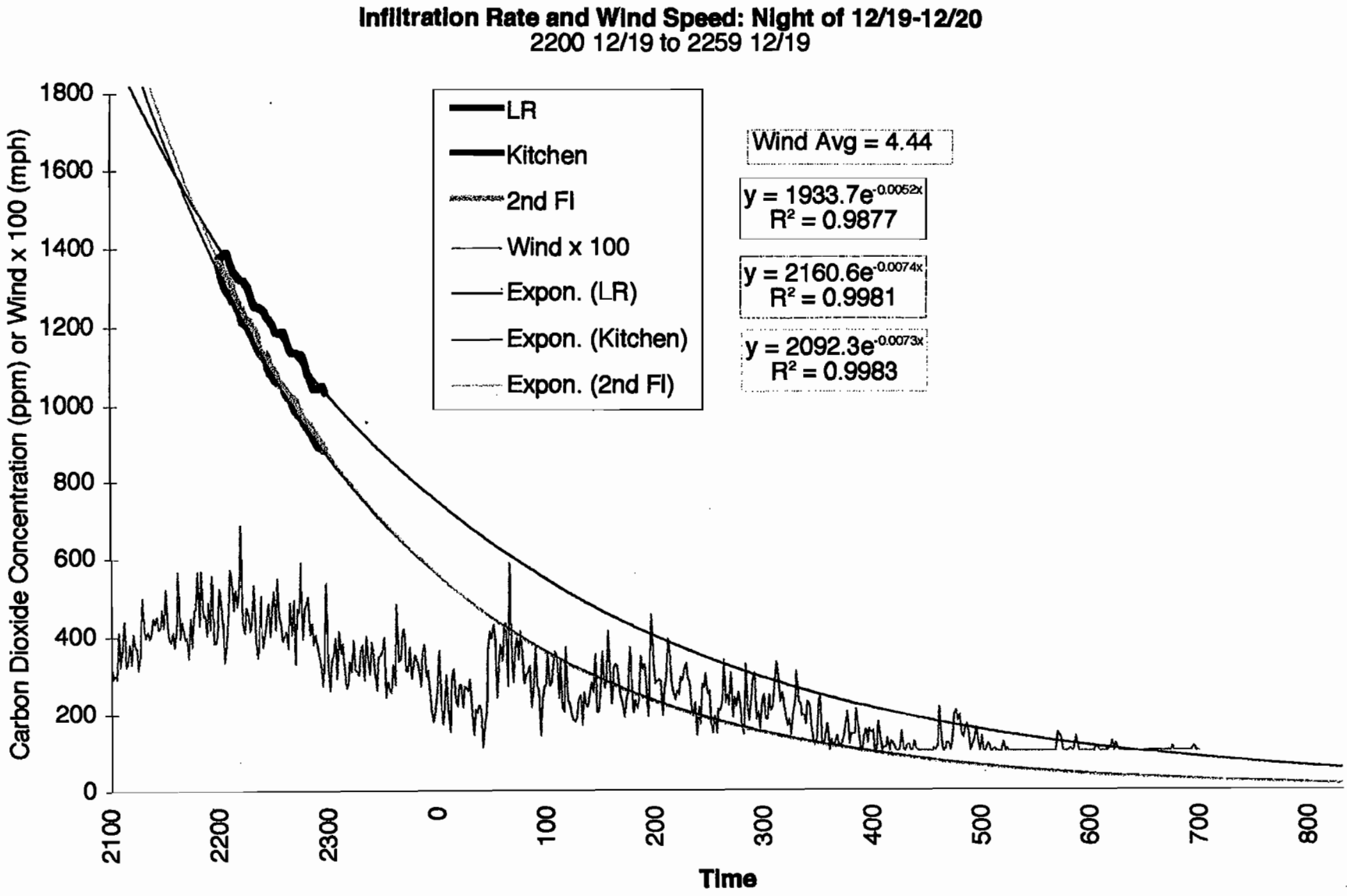
The chosen evening featured a very slight increase in Δt as the night progressed, combined with the decrease in wind speed. In the plot below, this slight change change in Δt appears to control the infiltration rate without regard for wind speed, supporting the above-mentioned project strategy.

Additional plots on pages C-40 through C-47 show details of the data used to create the graph below.

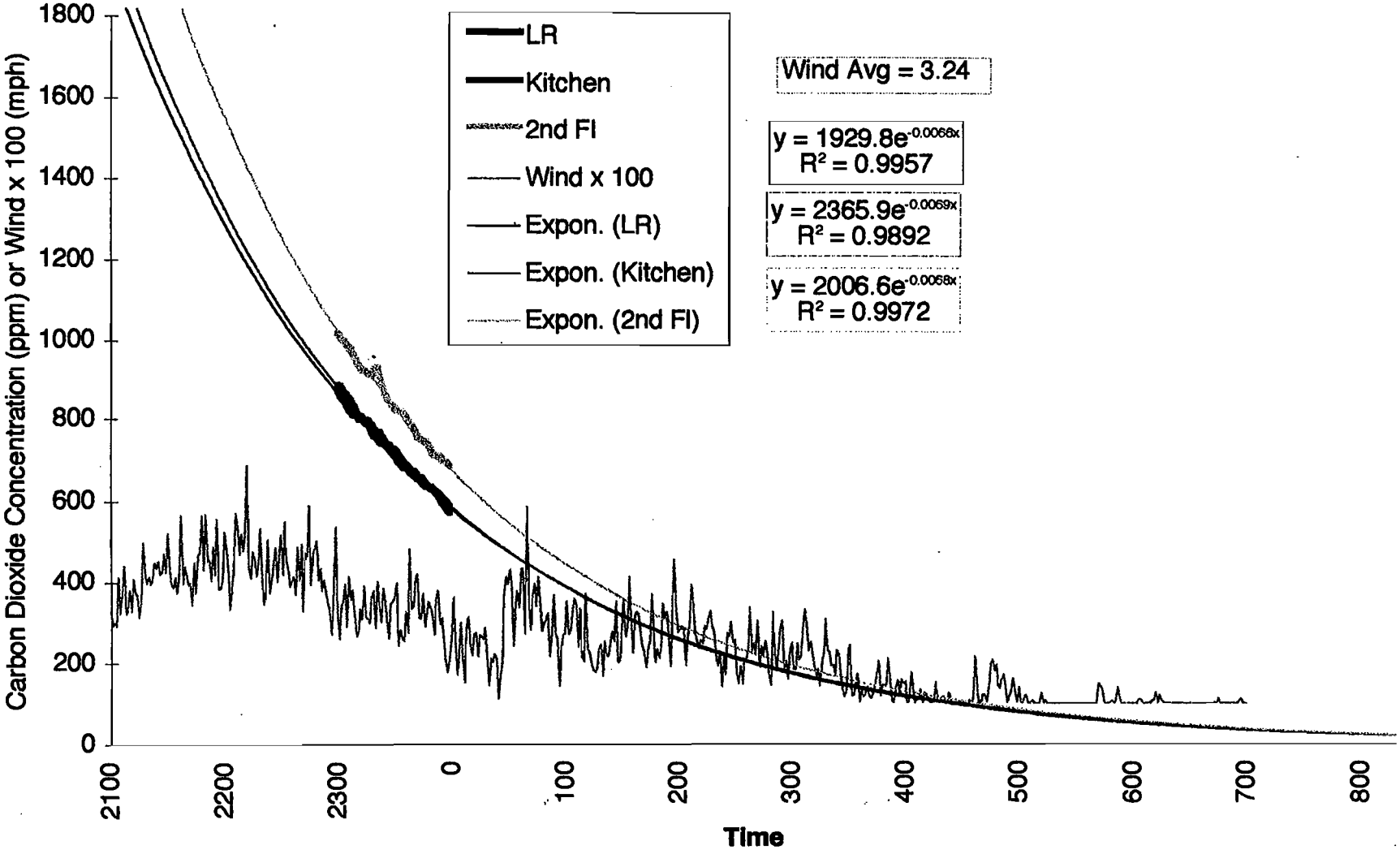


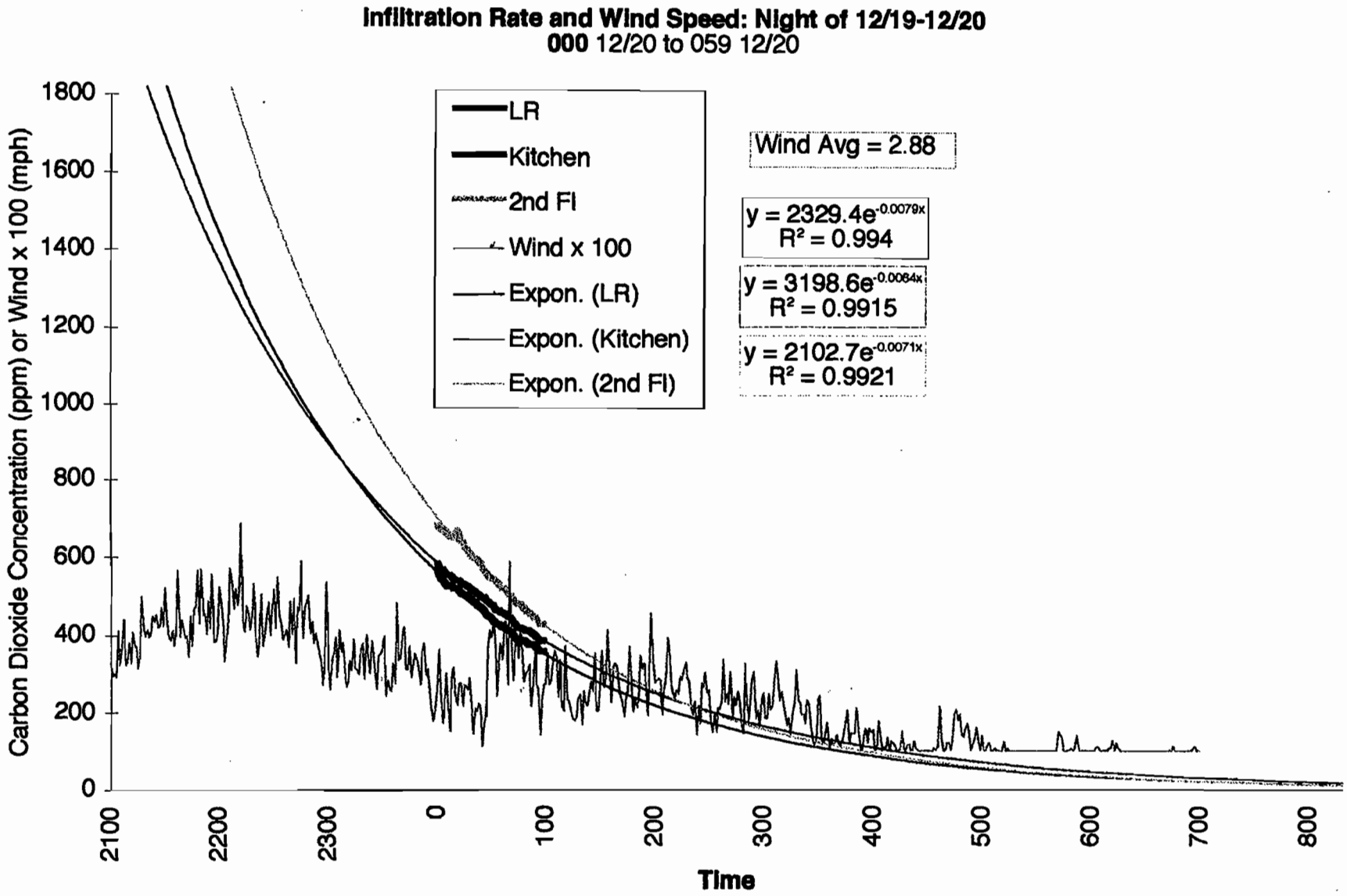
Infiltration Rate and Wind Speed: Night of 12/19-12/20



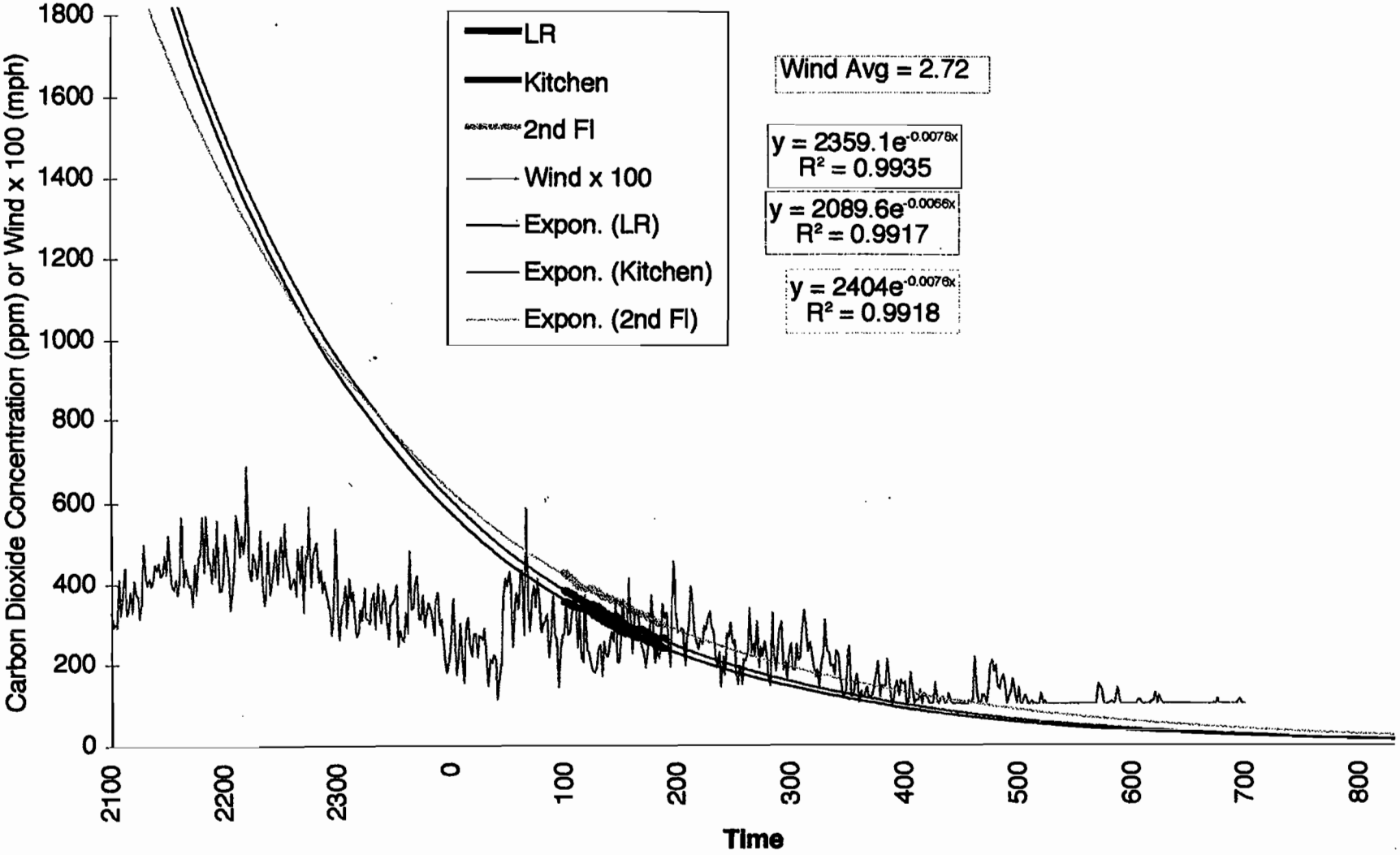

Infiltration Rate and Wind Speed: Night of 12/19-12/20
2200 12/19 to 2259 12/19
LR
Kitchen
2nd Fl
Wind x 100
Expon. (LR)
Expon. (Kitchen)
Expon. (2nd Fl)
Wind Avg = 4.44
y = 1933.7e-0.0052x
R² = 0.9877
y = 2160.6e-0.0074x
R² = 0.9981
y = 2092.3e-0.0073x
R² = 0.9983
Carbon Dioxide Concentration (ppm) or Wind x 100 (mph)
1800
1600
1400
1200
1000
800
600
400
200
0
2100
2200
2300
0
100
200
300
400
500
600
700
800
Time

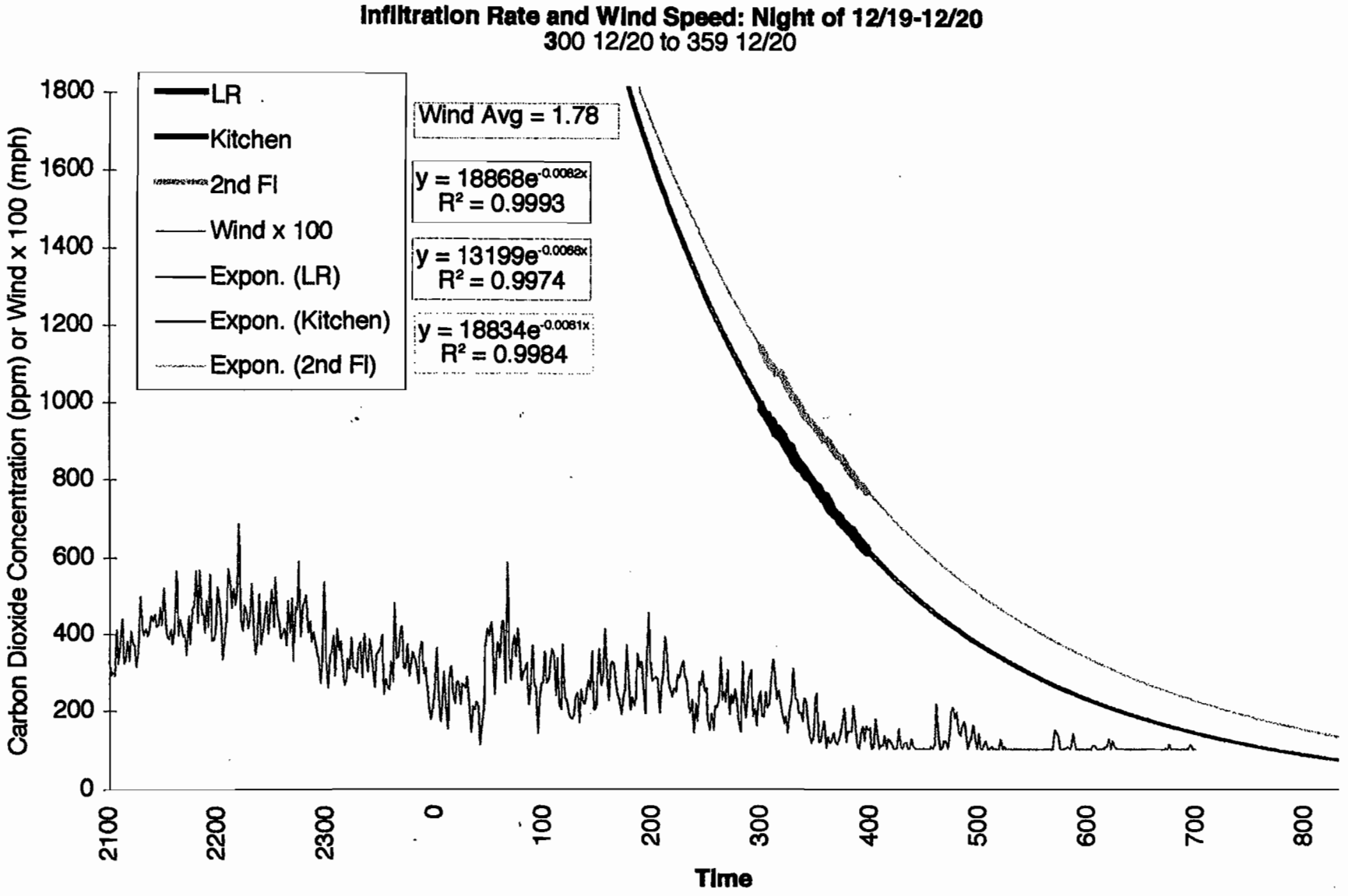
Infiltration Rate and Wind Speed: Night of 12/19-12/20
2300 12/19 to 2359 12/19

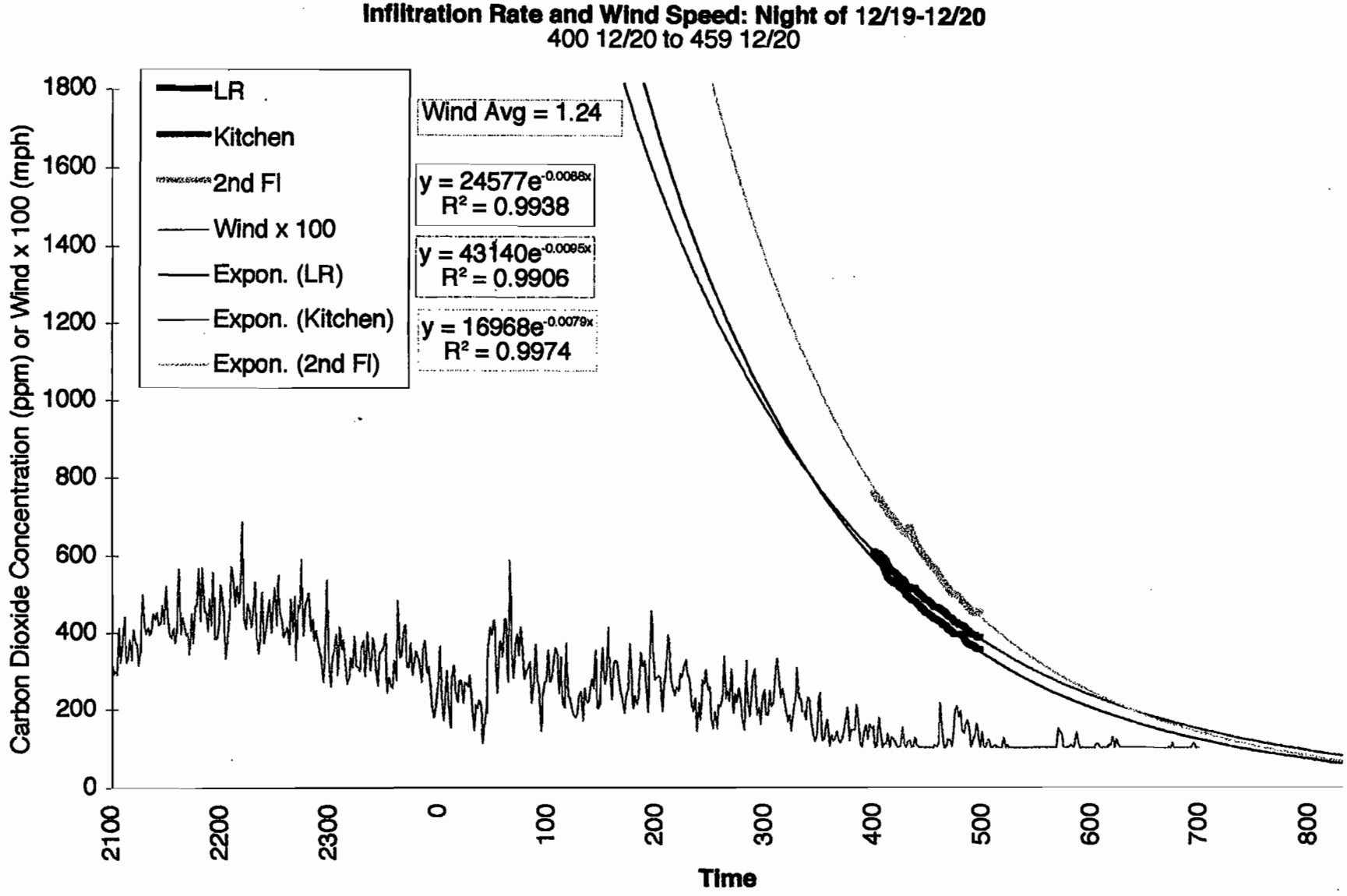


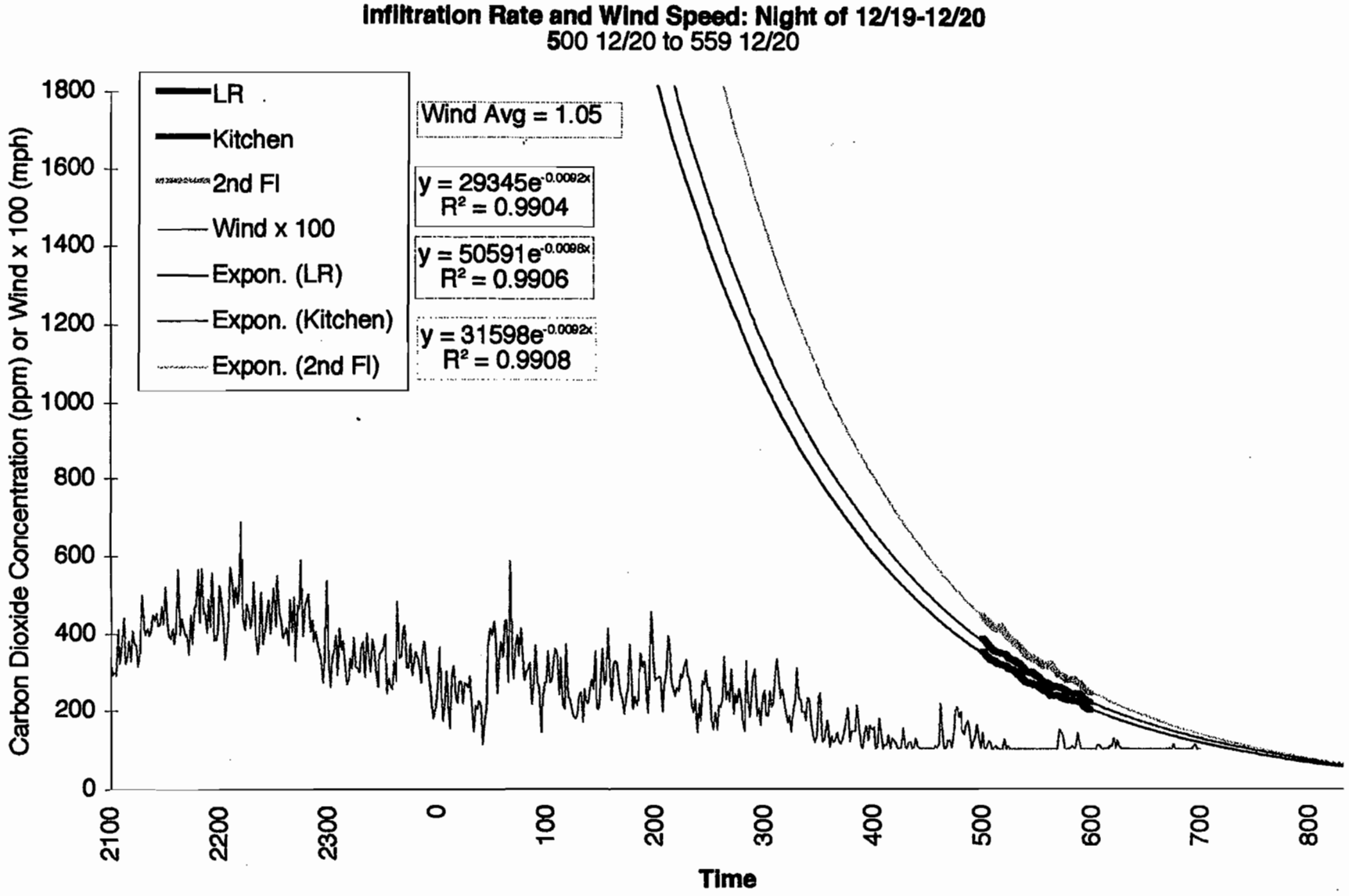

Infiltration Rate and Wind Speed: Night of 12/19-12/20
000 12/20 to 059 12/20
LR
Kitchen
2nd Fl
Wind x 100
Expon. (LR)
Expon. (Kitchen)
Expon. (2nd Fl)
Wind Avg = 2.88
y = 2329.4e-0.0079x
R² = 0.994
y = 3198.6e-0.0084x
R² = 0.9915
y = 2102.7e-0.0071x
R² = 0.9921
Carbon Dioxide Concentration (ppm) or Wind x 100 (mph)
1800
1600
1400
1200
1000
800
600
400
200
0
2100
2200
2300
0
100
200
300
400
500
600
700
800
Time

Infiltration Rate and Wind Speed: Night of 12/19-12/20
100 12/20 to 153 12/20




Infiltration Rate and Wind Speed: Night of 12/19-12/20
300 12/20 to 359 12/20
LR
Kitchen
2nd Fl
Wind x 100
Expon. (LR)
Expon. (Kitchen)
Expon. (2nd Fl)
Wind Avg = 1.78
y = 18868e-0.0082x
R² = 0.9993
y = 13199e-0.0068x
R² = 0.9974
y = 18834e-0.0081x
R² = 0.9984
Carbon Dioxide Concentration (ppm) or Wind x 100 (mph)
0
200
400
600
800
1000
1200
1400
1600
1800
2100
2200
2300
0
100
200
300
400
500
600
700
800
Time


Infiltration Rate and Wind Speed: Night of 12/19-12/20
400 12/20 to 459 12/20
LR
Kitchen
2nd Fl
Wind x 100
Expon. (LR)
Expon. (Kitchen)
Expon. (2nd Fl)
Wind Avg = 1.24
y = 24577e-0.0068x
R² = 0.9938
y = 43140e-0.0095x
R² = 0.9906
y = 16968e-0.0079x
R² = 0.9974
Carbon Dioxide Concentration (ppm) or Wind x 100 (mph)
1800
1600
1400
1200
1000
800
600
400
200
0
2100
2200
2300
0
100
200
300
400
500
600
700
800
Time


Infiltration Rate and Wind Speed: Night of 12/19-12/20
500 12/20 to 559 12/20
LR
Kitchen
2nd Fl
Wind x 100
Expon. (LR)
Expon. (Kitchen)
Expon. (2nd Fl)
Wind Avg = 1.05
y = 29345e-0.0092x
R² = 0.9904
y = 50591e-0.0098x
R² = 0.9906
y = 31598e-0.0092x
R² = 0.9908
Carbon Dioxide Concentration (ppm) or Wind x 100 (mph)
0
200
400
600
800
1000
1200
1400
1600
1800
2100
2200
2300
0
100
200
300
400
500
600
700
800
Time

SUPPLY DUCT SURFACE AREA

supply trunk and plenum		sq ft
	plenum	25.9
	trunk take-off	4.0
	8x18x9'10"	43.0
	8x16x5'51/2"	22.1
	taper between	1.8
	8x16 end	0.9
	total	**97.6**

2nd fl risers		
	(3) 3.25" x 10" x 12'	**79.5**

remaining basement duct - per lineal foot or per piece surface area

elbow/round	2.4	sq ft per lf
take-off	0.9	sq ft
regular boot	1.4	sq ft
torpedo boot	1.2	sq ft
stub riser	2.2	sq ft per lf

remaining basement duct

	lf or pieces	sq ft		TOTAL sq ft
straight 6" round	54.0	127.2		354.8
elbows	17	26.8		
takeoffs	9	8.1	minus all take-off holes	-4.6
boots	7	9.5		350.2
torpedos	2	2.4		
riser	1.7	3.6	percent basement	0.77
		177.7	percent inside	0.23

RETURN DUCT SURFACE AREA
pans include top surface as basement

	sq ft
plenum	34.9
old duct to R-2 pan	117.7
R-2 pan	41.5
R-2 stair landing enclosure	32.0
R-1 pan	82.9
R-3 1st section - duct	74.4
R-3 2nd section - pan	94.5
total	**477.9**
minus plenum hole in old duct	-2.0
minus R-2 pan hole in old duct	-7.3
minus R-1 pan hole in old duct	-2.0
minus R-3 pan hole in R-3 1st section duct	-2.0
R-3 outside - bay wdo overhang and end rim	13.1
R-1 outside - end rim	2.2
R-2 outside - stair landing enclosure outside wall	8.0
TOTAL	487.9
percent basement	0.887
percent outside	0.048
percent inside	0.066

INSULATED SUPPLY DUCT SURFACE AREA

		sq ft	
supply trunk and plenum			
	plenum	25.9	unchanged
	trunk take-off	4.0	unchanged
	8x18x9'10"	59.8	73" circumference
	8x16x5'51/2"	27.3	60" circumference
	taper between	2.4	70" avg circumference
	8x16 end	1.5	11" x 20"
	total	**121.0**	
2nd fl risers			
	(3) 3.25" x 10" x 12'	**79.5**	unchanged

remaining basement duct - per lineal foot or per piece surface area

elbow/round	2.4	sq ft per lf
take-off	0.9	sq ft
regular boot	1.4	sq ft
torpedo boot	1.2	sq ft
stub riser	2.2	sq ft per lf

	lf or pieces	minus insulated	sections equals	sf	
straight 6" round	54.0	-32.4		21.6	50.9
elbows	17	-3		14	22.1
takeoffs	9	-6		3	2.7
boots	7	0		7	9.5
torpedos	2	0		2	2.4
riser	1.7	0		1.7	3.6
		uninsulated branch ducts and fittings			**91.2**

Insulated branch ducts	lf or pieces	sq ft	
single	15.9	45.1	34" circumference
double	8.5	34.0	48" circumference 2 pipes in one wrap
takeoffs	6	6.0	
elbows	3	7.5	
		92.6	insulated branch ducts and fittings

	TOTAL	
	384.2	insulated = R 9.3
minus all take-off holes	-4.6	uninsulated = R 1.0
	379.6	weighted total R-value
		5.03
percent basement	0.79	
percent inside	0.21	

Configuration 1		Configuration 2		Configuration 3	
Q25,s	152 cfm	Q24,s	402 cfm	Q20,s	389 cfm
ΔPs	21.2 Pa	ΔPs	15.0 Pa	ΔPs	14.1 Pa
Qs	138 cfm	Qs	303 cfm	Qs	315 cfm
		return lkg not remeasured			
Q25,r	239 cfm	Q25,r	239 cfm	Q8,r	600 cfm
ΔPr	3.8 Pa	ΔPr	3.8 Pa	ΔPr	3.8 Pa
Qr	77 cfm	Qr	77 cfm	Qr	382 cfm
PP		PP		PP	
	41.7 Pa		32.9 Pa		32.4 Pa
	19.3 Pa		10.9 Pa		10.5 Pa
	16.3 Pa		10.7 Pa		9.9 Pa
	21.5 Pa		14.0 Pa		13.5 Pa
	14.5 Pa		11.1 Pa		13.4 Pa
	22.0 Pa		13.6 Pa		10.6 Pa
	18.5 Pa		13.4 Pa		12.1 Pa
	18.5 Pa		13.9 Pa		11.5 Pa
	18.2 Pa		14.5 Pa		12.9 Pa
Avg	**21.2 Pa**	**Avg**	**15.0 Pa**	**Avg**	**14.1 Pa**
Ret Plenum		Ret Plenum		Ret Plenum	
	7.6 Pa		7.6 Pa		7.5 Pa

Configuration 4		Configuration 5	
Q28,s	173 cfm	Q23,s	144 cfm
ΔPs	22.2 Pa	ΔPs	23.8 Pa
Qs	169 cfm	Qs	147 cfm
Q11,r	684 cfm	Q23,r	261 cfm
ΔPr	3.3 Pa	ΔPr	3.7 Pa
Qr	329 cfm	Qr	87 cfm

PP	PP
40.0 Pa	42.0 Pa
20.0 Pa	22.0 Pa
16.0 Pa	19.0 Pa
23.0 Pa	26.0 Pa
17.0 Pa	19.0 Pa
23.5 Pa	26.0 Pa
19.0 Pa	22.0 Pa
20.0 Pa	19.0 Pa
21.0 Pa	19.0 Pa
Avg 22.2 Pa	**Avg 23.8 Pa**

Ret Plenum	Ret Plenum
6.5 Pa	7.4 Pa

Appendix D

Standard 152P Calculations

Draft ASHRAE standard 152 duct efficiency calculations						
Aug-97						
INPUT PARAMETERS			CALCULATED PARAMETERS			
	Value used in calculation	**Notes**				
Conditioned floor area, (ft^2)	2216		Heating seasonal temperature	18.0		
Supply Duct Surface Area, (ft^2)	350		Cooling Seasonal temperature	-16.0		
Return Duct Surface Area, (ft^2)	488		Ground Temperature for basements	1.0		
Fraction of supply duct in attic	0		Fraction of supply duct outside conditioned space	0.8		
Fraction of supply duct in garage	0		Fraction of return duct outside conditioned space	0.9		
Fraction of supply duct in unvented & uninsulated crawlspace	0		Design Supply Duct Zone temperature, Heating, (F)	21.3	Design Temp. diff for supply, dTs, heating	46.7
Fraction of supply duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Seasonal Supply Duct Zone temperature, Heating, (F)	24.5	Seasonal Temp. diff for supply, dTs, heating	43.5
Fraction of supply duct in unvented crawlspace with insulated building floor	0		Limited Design Return Duct Zone temperature, Heating, (C)	22.0	Design Temp. diff for return, dTr, heating	46.0
Fraction of supply duct in Vented & uninsulated crawlspace	0		Limited Seasonal Return Duct Zone temperature, Heating, (C)	25.4	Seasonal Temp. diff for return, dTr, heating	42.6
Fraction of supply duct in Vented crawlspace with insulated building floor and crawlspace walls	0		Design Supply Duct Zone temperature, Cooling, (F)	0.5	Design Temp. diff for supply, dTs, cooling	-0.5

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152 Calculation - Duct Configuration #1; Supply and Return Ducts Sealed

Fraction of supply duct in Vented crawlspace with insulated building floor	0		Seasonal Supply Duct Zone temperature, Cooling, (F)	-2.7	Seasonal Temp. diff for supply, dTs, cooling	2.7
Fraction of supply duct in uninsulated basement	0.773	All else interior	Limited Design Return Duct Zone temperature, Cooling, (C)	0.5	Design Temp. diff for return, dTr, cooling	-0.5
Fraction of supply duct in basement with insulated walls	0		Limited Seasonal Return Duct Zone temperature, Cooling, (C)	-9.5	Seasonal Temp. diff for return, dTr, cooling	9.5
Fraction of supply duct in basement with insulated ceiling	0		Design Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	1		
Fraction of supply duct under slab	0		Seasonal Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	0		
Fraction of supply duct in exterior walls	0		Limited Design Return Duct Zone Enthalpy, Cooling, (J/Kg)	1		
Fraction of return duct in attic	0		Limited Seasonal Return Duct Zone Enthalpy, Cooling, (J/Kg)	-2		
Fraction of return duct in garage	0		Fcycloss	0.04		
Fraction of return duct in unvented & uninsulated crawlspace	0		Fflow, heating	1		
Fraction of return duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Fflow,cooling,TXV	1		
Fraction of return duct in unvented crawlspace with insulated building floor	0		Fflow,cooling,non-TXV	1		
Fraction of return duct in Vented & uninsulated crawlspace	0.048	1st fl bay wdo overhang				
Fraction of return duct in Vented crawlspace with insulated building floor and crawlspace walls	0					
Fraction of return duct in Vented crawlspace with insulated building floor	0		Supply Duct Thermal regain	0.50	System Thermal regain	0.50
Fraction of return duct in uninsulated basement	0.887		Return Duct Thermal regain	0.50		

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152 Calculation - Duct Configuration #1; Supply and Return Ducts Sealed

Fraction of return duct in basement with insulated walls	0		Infiltration, Fan off, (cfm)	114	LOW SPEED	
Fraction of return duct in basement with insulated ceiling	0		Heating as	0.814765	Heating as	#DIV/0!
Fraction of return duct under slab	0		Heating, ar	0.896644	Heating, ar	#DIV/0!
Fraction of return duct in exterior walls	0		Cooling as	#DIV/0!	Cooling as	#DIV/0!
Supply Duct R value (hft^2F/Btu)	1		Cooling ar	#DIV/0!	Cooling ar	#DIV/0!
Return Duct R value (hft^2F/Btu)	1		Temperature change across heat exchanger, dTe, heating	142.14		
Indoor Temperature, heating (F)	68		Temperature change across heat exchanger, dTe, heating, low capacity	#DIV/0!		
Indoor Temperature, cooling (F)			Temperature change across heat exchanger, dTe, cooling	#DIV/0!		
Heating Design temperature, ASHRAE 97.5%, (F)	2		Temperature change across heat exchanger, dTe, cooling, low capacity	#DIV/0!	LOW SPEED	
Cooling Design temperature, ASHRAE, 2.5%, (F)			Heating, Bs	0.71	Heating, Bs	#DIV/0!
T wetbulb design, (F)			Heating, Br	0.57	Heating, Br	#DIV/0!
T wetbulb indoor, (F)			Cooling, Bs	#DIV/0!	Cooling, Bs	#DIV/0!
Is there solar gain reduction in the attic? [Y/N]	N		Cooling, Br	#DIV/0!	Cooling, Br	#DIV/0!
House Volume, (ft^3)	19612	default is 8.2feetxFloor Area	Imbalance Flow, Heating, (cfm)	61	Imbalance Flow, Heating, (cfm)	0
Equipment Heating Capacity, [Btu/hour]	114,365	Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here	Imbalance Flow, Cooling, (cfm)	0	Imbalance Flow, Cooling, (cfm)	0
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number)		Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here				

152 Calculation - Duct Configuration #1; Supply and Return Ducts Sealed

Equipment Heating Capacity, [Btu/hour], LOW		For two speed equipment, enter lower capacity here				
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number), LOW		For two speed equipment, enter lower capacity here				
Heating Fan Flow, (cfm)	745	For two speed equipment, enter higher flow here				
Cooling Fan Flow, (cfm)		For two speed equipment, enter higher flow here				
Heating Supply duct leakage (cfm)	138	For two speed equipment, enter higher flow here				
Heating Return duct leakage (cfm)	77	For two speed equipment, enter higher flow here	Net building infiltration, heating, (cfm)	146.0206	Net building infiltration, heating, (cfm)	117.1469
Cooling Supply duct leakage (cfm)		For two speed equipment, enter higher flow here	Net building infiltration, cooling, (cfm)	117.1469	Net building infiltration, cooling, (cfm)	117.1469
Cooling Return duct leakage (cfm)		For two speed equipment, enter higher flow here	Load Factor, heating, design	0.981	Recovery Factor, heating, design	1.697
Heating Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, heating, seasonal	0.943	Recovery Factor, heating, seasonal	1.664
Cooling Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, design	#DIV/0!	Recovery Factor, cooling, design	#DIV/0!
Heating Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, seasonal	#DIV/0!	Recovery Factor, cooling, seasonal	#DIV/0!
Heating Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, design	1		
Cooling Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, seasonal	1		

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Cooling Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment Factor, Cooling, design	1		
For Duct Thermal Mass Correction, Enter F for flex duct or duct board, M for sheet metal	M		Equipment Factor, cooling, seasonal	#DIV/0!		
For equipment efficiency correction, Enter 1 for ACCA manual D design, 2 without Manual D design	1					
Enter 1 for single speed cooling equipment, 2 for multispeed cooling equipment						
Enter 1 for single speed heating equipment, 2 for multispeed heating equipment	1	A heat pump with strip heat is a variable capacity piece of equipment				
For Vented Attic, Enter V for vented, U for unvented	V					
For cooling systems, Enter T for TXV control, O for other control	O					
For heating systems, Enter H for heat pump, O for other system	O					
Supply plenum dry bulb temperature for cooling systems, [F]						
Number of return Registers	3					
OUTPUT PARAMETERS						
Delivery Effectiveness			**Distribution System Efficiency**			
Heating, design	0.41		Heating, design	0.69		
Heating, seasonal	0.43		Heating, seasonal	0.67		
Cooling, design	#DIV/0!		Cooling, design	#DIV/0!		
Cooling, seasonal	#DIV/0!		Cooling, seasonal	#DIV/0!		

Draft ASHRAE standard 152 duct efficiency calculations						
Aug-97						
INPUT PARAMETERS			CALCULATED PARAMETERS			
	Value used in calculation	**Notes**				
Conditioned floor area, (ft^2)	2216		Heating seasonal temperature	18.0		
Supply Duct Surface Area, (ft^2)	350		Cooling Seasonal temperature	-16.0		
Return Duct Surface Area, (ft^2)	488		Ground Temperature for basements	1.0		
Fraction of supply duct in attic	0		Fraction of supply duct outside conditioned space	0.8		
Fraction of supply duct in garage	0		Fraction of return duct outside conditioned space	0.9		
Fraction of supply duct in unvented & uninsulated crawlspace	0		Design Supply Duct Zone temperature, Heating, (F)	21.3	Design Temp. diff for supply, dTs, heating	46.7
Fraction of supply duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Seasonal Supply Duct Zone temperature, Heating, (F)	24.5	Seasonal Temp. diff for supply, dTs, heating	43.5
Fraction of supply duct in unvented crawlspace with insulated building floor	0		Limited Design Return Duct Zone temperature, Heating, (C)	22.0	Design Temp. diff for return, dTr, heating	46.0
Fraction of supply duct in Vented & uninsulated crawlspace	0		Limited Seasonal Return Duct Zone temperature, Heating, (C)	25.4	Seasonal Temp. diff for return, dTr, heating	42.6
Fraction of supply duct in Vented crawlspace with insulated building floor and crawlspace walls	0		Design Supply Duct Zone temperature, Cooling, (F)	0.5	Design Temp. diff for supply, dTs, cooling	-0.5

152 Calculation - Duct Configuration #2; Supply Duct Leakage Only

Fraction of supply duct in Vented crawlspace with insulated building floor	0		Seasonal Supply Duct Zone temperature, Cooling, (F)	-2.7	Seasonal Temp. diff for supply, dTs, cooling	2.7
Fraction of supply duct in uninsulated basement	0.773		Limited Design Return Duct Zone temperature, Cooling, (C)	0.5	Design Temp. diff for return, dTr, cooling	-0.5
Fraction of supply duct in basement with insulated walls	0		Limited Seasonal Return Duct Zone temperature, Cooling, (C)	-9.5	Seasonal Temp. diff for return, dTr, cooling	9.5
Fraction of supply duct in basement with insulated ceiling	0		Design Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	1		
Fraction of supply duct under slab	0		Seasonal Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	0		
Fraction of supply duct in exterior walls	0		Limited Design Return Duct Zone Enthalpy, Cooling, (J/Kg)	1		
Fraction of return duct in attic	0		Limited Seasonal Return Duct Zone Enthalpy, Cooling, (J/Kg)	-2		
Fraction of return duct in garage	0		Fcycloss	0.04		
Fraction of return duct in unvented & uninsulated crawlspace	0		Fflow, heating	1		
Fraction of return duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Fflow,cooling,TXV	1		
Fraction of return duct in unvented crawlspace with insulated building floor	0		Fflow,cooling,non-TXV	1		
Fraction of return duct in Vented & uninsulated crawlspace	0.048					
Fraction of return duct in Vented crawlspace with insulated building floor and crawlspace walls	0					
Fraction of return duct in Vented crawlspace with insulated building floor	0		Supply Duct Thermal regain	0.50	System Thermal regain	0.50
Fraction of return duct in uninsulated basement	0.887		Return Duct Thermal regain	0.50		

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152 Calculation - Duct Configuration #2; Supply Duct Leakage Only

Fraction of return duct in basement with insulated walls	0		Infiltration, Fan off, (cfm)	114	LOW SPEED	
Fraction of return duct in basement with insulated ceiling	0		Heating as	0.57975	Heating as	#DIV/0!
Fraction of return duct under slab	0		Heating, ar	0.893204	Heating, ar	#DIV/0!
Fraction of return duct in exterior walls	0		Cooling as	#DIV/0!	Cooling as	#DIV/0!
Supply Duct R value (hft^2F/Btu)	1		Cooling ar	#DIV/0!	Cooling ar	#DIV/0!
Return Duct R value (hft^2F/Btu)	1		Temperature change across heat exchanger, dTe, heating	146.42		
Indoor Temperature, heating (F)	68		Temperature change across heat exchanger, dTe, heating, low capacity	#DIV/0!		
Indoor Temperature, cooling (F)			Temperature change across heat exchanger, dTe, cooling	#DIV/0!		
Heating Design temperature, ASHRAE 97.5%, (F)	2		Temperature change across heat exchanger, dTe, cooling, low capacity	#DIV/0!	LOW SPEED	
Cooling Design temperature, ASHRAE, 2.5%, (F)			Heating, Bs	0.71	Heating, Bs	#DIV/0!
T wetbulb design, (F)			Heating, Br	0.56	Heating, Br	#DIV/0!
T wetbulb indoor, (F)			Cooling, Bs	#DIV/0!	Cooling, Bs	#DIV/0!
Is there solar gain reduction in the attic? [Y/N]	N		Cooling, Br	#DIV/0!	Cooling, Br	#DIV/0!
House Volume, (ft^3)	19612	default is 8.2feetxFloor Area	Imbalance Flow, Heating, (cfm)	226	Imbalance Flow, Heating, (cfm)	0
Equipment Heating Capacity, [Btu/hour]	114,018	Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here	Imbalance Flow, Cooling, (cfm)	0	Imbalance Flow, Cooling, (cfm)	0
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number)		Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here				

152 Calculation - Duct Configuration #2; Supply Duct Leakage Only

Equipment Heating Capacity, [Btu/hour], LOW		For two speed equipment, enter lower capacity here				
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number), LOW		For two speed equipment, enter lower capacity here				
Heating Fan Flow, (cfm)	721	For two speed equipment, enter higher flow here				
Cooling Fan Flow, (cfm)		For two speed equipment, enter higher flow here				
Heating Supply duct leakage (cfm)	303	For two speed equipment, enter higher flow here				
Heating Return duct leakage (cfm)	77	For two speed equipment, enter higher flow here	Net building infiltration, heating, (cfm)	285.3542	Net building infiltration, heating, (cfm)	117.1469
Cooling Supply duct leakage (cfm)		For two speed equipment, enter higher flow here	Net building infiltration, cooling, (cfm)	117.1469	Net building infiltration, cooling, (cfm)	117.1469
Cooling Return duct leakage (cfm)		For two speed equipment, enter higher flow here	Load Factor, heating, design	0.903	Recovery Factor, heating, design	2.207
Heating Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, heating, seasonal	0.886	Recovery Factor, heating, seasonal	2.159
Cooling Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, design	#DIV/0!	Recovery Factor, cooling, design	#DIV/0!
Heating Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, seasonal	#DIV/0!	Recovery Factor, cooling, seasonal	#DIV/0!
Heating Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, design	1		
Cooling Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, seasonal	1		

Cooling Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment Factor, Cooling, design	1		
For Duct Thermal Mass Correction, Enter F for flex duct or duct board, M for sheet metal	M		Equipment Factor, cooling, seasonal	#DIV/0!		
For equipment efficiency correction, Enter 1 for ACCA manual D design, 2 without Manual D design	1					
Enter 1 for single speed cooling equipment, 2 for multispeed cooling equipment						
Enter 1 for single speed heating equipment, 2 for multispeed heating equipment	1	A heat pump with strip heat is a variable capacity piece of equipment				
For Vented Attic, Enter V for vented, U for unvented	V					
For cooling systems, Enter T for TXV control, O for other control	O					
For heating systems, Enter H for heat pump, O for other system	O					
Supply plenum dry bulb temperature for cooling systems, [F]						
Number of return Registers	3					
OUTPUT PARAMETERS						
Delivery Effectiveness			**Distribution System Efficiency**			
Heating, design	**0.29**		**Heating, design**	**0.58**		
Heating, seasonal	**0.30**		**Heating, seasonal**	**0.57**		
Cooling, design	**#DIV/0!**		**Cooling, design**	**#DIV/0!**		
Cooling, seasonal	**#DIV/0!**		**Cooling, seasonal**	**#DIV/0!**		

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152 Calculation - Duct Configuration #3; Supply Duct Leakage and Return Duct Leakage

Draft ASHRAE standard 152 duct efficiency calculations						
Aug-97						
INPUT PARAMETERS			CALCULATED PARAMETERS			
	Value used in calculation	**Notes**				
Conditioned floor area, (ft^2)	2216		Heating seasonal temperature	18.0		
Supply Duct Surface Area, (ft^2)	350		Cooling Seasonal temperature	-16.0		
Return Duct Surface Area, (ft^2)	488		Ground Temperature for basements	1.0		
Fraction of supply duct in attic	0		Fraction of supply duct outside conditioned space	0.8		
Fraction of supply duct in garage	0		Fraction of return duct outside conditioned space	0.9		
Fraction of supply duct in unvented & uninsulated crawlspace	0		Design Supply Duct Zone temperature, Heating, (F)	21.3	Design Temp. diff for supply, dTs, heating	46.7
Fraction of supply duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Seasonal Supply Duct Zone temperature, Heating, (F)	24.5	Seasonal Temp. diff for supply, dTs, heating	43.5
Fraction of supply duct in unvented crawlspace with insulated building floor	0		Limited Design Return Duct Zone temperature, Heating, (C)	22.0	Design Temp. diff for return, dTr, heating	46.0
Fraction of supply duct in Vented & uninsulated crawlspace	0		Limited Seasonal Return Duct Zone temperature, Heating, (C)	25.4	Seasonal Temp. diff for return, dTr, heating	42.6
Fraction of supply duct in Vented crawlspace with insulated building floor and crawlspace walls	0		Design Supply Duct Zone temperature, Cooling, (F)	0.5	Design Temp. diff for supply, dTs, cooling	-0.5

152 Calculation - Duct Configuration #3; Supply Duct Leakage and Return Duct Leakage

Fraction of supply duct in Vented crawlspace with insulated building floor	0		Seasonal Supply Duct Zone temperature, Cooling, (F)	-2.7	Seasonal Temp. diff for supply, dTs, cooling	2.7
Fraction of supply duct in uninsulated basement	0.773		Limited Design Return Duct Zone temperature, Cooling, (C)	0.5	Design Temp. diff for return, dTr, cooling	-0.5
Fraction of supply duct in basement with insulated walls	0		Limited Seasonal Return Duct Zone temperature, Cooling, (C)	-9.5	Seasonal Temp. diff for return, dTr, cooling	9.5
Fraction of supply duct in basement with insulated ceiling	0		Design Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	1		
Fraction of supply duct under slab	0		Seasonal Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	0		
Fraction of supply duct in exterior walls	0		Limited Design Return Duct Zone Enthalpy, Cooling, (J/Kg)	1		
Fraction of return duct in attic	0		Limited Seasonal Return Duct Zone Enthalpy, Cooling, (J/Kg)	-2		
Fraction of return duct in garage	0		Fcycloss	0.04		
Fraction of return duct in unvented & uninsulated crawlspace	0		Fflow, heating	1		
Fraction of return duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Fflow,cooling,TXV	1		
Fraction of return duct in unvented crawlspace with insulated building floor	0		Fflow,cooling,non-TXV	1		
Fraction of return duct in Vented & uninsulated crawlspace	0.048					
Fraction of return duct in Vented crawlspace with insulated building floor and crawlspace walls	0					
Fraction of return duct in Vented crawlspace with insulated building floor	0		Supply Duct Thermal regain	0.50	System Thermal regain	0.50
Fraction of return duct in uninsulated basement	0.887		Return Duct Thermal regain	0.50		

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152 Calculation - Duct Configuration #3; Supply Duct Leakage and Return Duct Leakage

Fraction of return duct in basement with insulated walls	0		Infiltration, Fan off, (cfm)	114	LOW SPEED	
Fraction of return duct in basement with insulated ceiling	0		Heating as	0.60076	Heating as	#DIV/0!
Fraction of return duct under slab	0		Heating, ar	0.515843	Heating, ar	#DIV/0!
Fraction of return duct in exterior walls	0		Cooling as	#DIV/0!	Cooling as	#DIV/0!
Supply Duct R value (hft^2F/Btu)	1		Cooling ar	#DIV/0!	Cooling ar	#DIV/0!
Return Duct R value (hft^2F/Btu)	1		Temperature change across heat exchanger, dTe, heating	132.17		
Indoor Temperature, heating (F)	68		Temperature change across heat exchanger, dTe, heating, low capacity	#DIV/0!		
Indoor Temperature, cooling (F)			Temperature change across heat exchanger, dTe, cooling	#DIV/0!		
Heating Design temperature, ASHRAE 97.5%, (F)	2		Temperature change across heat exchanger, dTe, cooling, low capacity	#DIV/0!	LOW SPEED	
Cooling Design temperature, ASHRAE, 2.5%, (F)			Heating, Bs	0.73	Heating, Bs	#DIV/0!
T wetbulb design, (F)			Heating, Br	0.59	Heating, Br	#DIV/0!
T wetbulb indoor, (F)			Cooling, Bs	#DIV/0!	Cooling, Bs	#DIV/0!
Is there solar gain reduction in the attic? [Y/N]	N		Cooling, Br	#DIV/0!	Cooling, Br	#DIV/0!
House Volume, (ft^3)	19612	default is 8.2feetxFloor Area	Imbalance Flow, Heating, (cfm)	67	Imbalance Flow, Heating, (cfm)	0
Equipment Heating Capacity, [Btu/hour]	112,627	Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here	Imbalance Flow, Cooling, (cfm)	0	Imbalance Flow, Cooling, (cfm)	0
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number)		Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here				

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152 Calculation - Duct Configuration #3; Supply Duct Leakage and Return Duct Leakage

Equipment Heating Capacity, [Btu/hour], LOW		For two speed equipment, enter lower capacity here				
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number), LOW		For two speed equipment, enter lower capacity here				
Heating Fan Flow, (cfm)	789	For two speed equipment, enter higher flow here				
Cooling Fan Flow, (cfm)		For two speed equipment, enter higher flow here				
Heating Supply duct leakage (cfm)	315	For two speed equipment, enter higher flow here				
Heating Return duct leakage (cfm)	382	For two speed equipment, enter higher flow here	Net building infiltration, heating, (cfm)	78.6564	Net building infiltration, heating, (cfm)	117.1469
Cooling Supply duct leakage (cfm)		For two speed equipment, enter higher flow here	Net building infiltration, cooling, (cfm)	117.1469	Net building infiltration, cooling, (cfm)	117.1469
Cooling Return duct leakage (cfm)		For two speed equipment, enter higher flow here	Load Factor, heating, design	1.023	Recovery Factor, heating, design	2.250
Heating Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, heating, seasonal	0.974	Recovery Factor, heating, seasonal	2.183
Cooling Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, design	#DIV/0!	Recovery Factor, cooling, design	#DIV/0!
Heating Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, seasonal	#DIV/0!	Recovery Factor, cooling, seasonal	#DIV/0!
Heating Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, design	1		
Cooling Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, seasonal	1		

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Cooling Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment Factor, Cooling, design	1		
For Duct Thermal Mass Correction, Enter F for flex duct or duct board, M for sheet metal	M		Equipment Factor, cooling, seasonal	#DIV/0!		
For equipment efficiency correction, Enter 1 for ACCA manual D design, 2 without Manual D design	1					
Enter 1 for single speed cooling equipment, 2 for multispeed cooling equipment						
Enter 1 for single speed heating equipment, 2 for multispeed heating equipment	1	A heat pump with strip heat is a variable capacity piece of equipment				
For Vented Attic, Enter V for vented, U for unvented	V					
For cooling systems, Enter T for TXV control, O for other control	O					
For heating systems, Enter H for heat pump, O for other system	O					
Supply plenum dry bulb temperature for cooling systems, [F]						
Number of return Registers	3					
OUTPUT PARAMETERS						
Delivery Effectiveness			**Distribution System Efficiency**			
Heating, design	**0.27**		**Heating, design**	**0.63**		
Heating, seasonal	**0.29**		**Heating, seasonal**	**0.61**		
Cooling, design	**#DIV/0!**		**Cooling, design**	**#DIV/0!**		
Cooling, seasonal	**#DIV/0!**		**Cooling, seasonal**	**#DIV/0!**		

152 Calculation - Duct Configuration #4; Return Duct Leakage Only

Draft ASHRAE standard 152 duct efficiency calculations						
Aug-97						
INPUT PARAMETERS			CALCULATED PARAMETERS			
	Value used in calculation	**Notes**				
Conditioned floor area, (ft^2)	2216		Heating seasonal temperature	18.0		
Supply Duct Surface Area, (ft^2)	350		Cooling Seasonal temperature	-16.0		
Return Duct Surface Area, (ft^2)	488		Ground Temperature for basements	1.0		
Fraction of supply duct in attic	0		Fraction of supply duct outside conditioned space	0.8		
Fraction of supply duct in garage	0		Fraction of return duct outside conditioned space	0.9		
Fraction of supply duct in unvented & uninsulated crawlspace	0		Design Supply Duct Zone temperature, Heating, (F)	21.3	Design Temp. diff for supply, dTs, heating	46.7
Fraction of supply duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Seasonal Supply Duct Zone temperature, Heating, (F)	24.5	Seasonal Temp. diff for supply, dTs, heating	43.5
Fraction of supply duct in unvented crawlspace with insulated building floor	0		Limited Design Return Duct Zone temperature, Heating, (C)	22.0	Design Temp. diff for return, dTr, heating	46.0
Fraction of supply duct in Vented & uninsulated crawlspace	0		Limited Seasonal Return Duct Zone temperature, Heating, (C)	25.4	Seasonal Temp. diff for return, dTr, heating	42.6
Fraction of supply duct in Vented crawlspace with insulated building floor and crawlspace walls	0		Design Supply Duct Zone temperature, Cooling, (F)	0.5	Design Temp. diff for supply, dTs, cooling	-0.5

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152 Calculation - Duct Configuration #4; Return Duct Leakage Only

Fraction of supply duct in Vented crawlspace with insulated building floor	0		Seasonal Supply Duct Zone temperature, Cooling, (F)	-2.7	Seasonal Temp. diff for supply, dTs, cooling	2.7
Fraction of supply duct in uninsulated basement	0.773		Limited Design Return Duct Zone temperature, Cooling, (C)	0.5	Design Temp. diff for return, dTr, cooling	-0.5
Fraction of supply duct in basement with insulated walls	0		Limited Seasonal Return Duct Zone temperature, Cooling, (C)	-9.5	Seasonal Temp. diff for return, dTr, cooling	9.5
Fraction of supply duct in basement with insulated ceiling	0		Design Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	1		
Fraction of supply duct under slab	0		Seasonal Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	0		
Fraction of supply duct in exterior walls	0		Limited Design Return Duct Zone Enthalpy, Cooling, (J/Kg)	1		
Fraction of return duct in attic	0		Limited Seasonal Return Duct Zone Enthalpy, Cooling, (J/Kg)	-2		
Fraction of return duct in garage	0		Fcycloss	0.04		
Fraction of return duct in unvented & uninsulated crawlspace	0		Fflow, heating	1		
Fraction of return duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Fflow,cooling,TXV	1		
Fraction of return duct in unvented crawlspace with insulated building floor	0		Fflow,cooling,non-TXV	1		
Fraction of return duct in Vented & uninsulated crawlspace	0.048					
Fraction of return duct in Vented crawlspace with insulated building floor and crawlspace walls	0					
Fraction of return duct in Vented crawlspace with insulated building floor	0		Supply Duct Thermal regain	0.50	System Thermal regain	0.50
Fraction of return duct in uninsulated basement	0.887		Return Duct Thermal regain	0.50		

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152 Calculation - Duct Configuration #4; Return Duct Leakage Only

Fraction of return duct in basement with insulated walls	0		Infiltration, Fan off, (cfm)	114	LOW SPEED	
Fraction of return duct in basement with insulated ceiling	0		Heating as	0.767538	Heating as	#DIV/0!
Fraction of return duct under slab	0		Heating, ar	0.547455	Heating, ar	#DIV/0!
Fraction of return duct in exterior walls	0		Cooling as	#DIV/0!	Cooling as	#DIV/0!
Supply Duct R value (hft^2F/Btu)	1		Cooling ar	#DIV/0!	Cooling ar	#DIV/0!
Return Duct R value (hft^2F/Btu)	1		Temperature change across heat exchanger, dTe, heating	146.99		
Indoor Temperature, heating (F)	68		Temperature change across heat exchanger, dTe, heating, low capacity	#DIV/0!		
Indoor Temperature, cooling (F)			Temperature change across heat exchanger, dTe, cooling	#DIV/0!		
Heating Design temperature, ASHRAE 97.5%, (F)	2		Temperature change across heat exchanger, dTe, cooling, low capacity	#DIV/0!	LOW SPEED	
Cooling Design temperature, ASHRAE, 2.5%, (F)			Heating, Bs	0.71	Heating, Bs	#DIV/0!
T wetbulb design, (F)			Heating, Br	0.56	Heating, Br	#DIV/0!
T wetbulb indoor, (F)			Cooling, Bs	#DIV/0!	Cooling, Bs	#DIV/0!
Is there solar gain reduction in the attic? [Y/N]	N		Cooling, Br	#DIV/0!	Cooling, Br	#DIV/0!
House Volume, (ft^3)	19612	default is 8.2feetxFloor Area	Imbalance Flow, Heating, (cfm)	160	Imbalance Flow, Heating, (cfm)	0
Equipment Heating Capacity, [Btu/hour]	115,408	Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here	Imbalance Flow, Cooling, (cfm)	0	Imbalance Flow, Cooling, (cfm)	0
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number)		Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here				

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152 Calculation - Duct Configuration #4; Return Duct Leakage Only

Equipment Heating Capacity, [Btu/hour], LOW		For two speed equipment, enter lower capacity here				
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number), LOW		For two speed equipment, enter lower capacity here				
Heating Fan Flow, (cfm)	727	For two speed equipment, enter higher flow here				
Cooling Fan Flow, (cfm)		For two speed equipment, enter higher flow here				
Heating Supply duct leakage (cfm)	169	For two speed equipment, enter higher flow here				
Heating Return duct leakage (cfm)	329	For two speed equipment, enter higher flow here	Net building infiltration, heating, (cfm)	0.0000	Net building infiltration, heating, (cfm)	117.1469
Cooling Supply duct leakage (cfm)		For two speed equipment, enter higher flow here	Net building infiltration, cooling, (cfm)	117.1469	Net building infiltration, cooling, (cfm)	117.1469
Cooling Return duct leakage (cfm)		For two speed equipment, enter higher flow here	Load Factor, heating, design	1.076	Recovery Factor, heating, design	1.849
Heating Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, heating, seasonal	1.011	Recovery Factor, heating, seasonal	1.803
Cooling Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, design	#DIV/0!	Recovery Factor, cooling, design	#DIV/0!
Heating Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, seasonal	#DIV/0!	Recovery Factor, cooling, seasonal	#DIV/0!
Heating Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, design	1		
Cooling Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, seasonal	1		

152 Calculation - Duct Configuration #4; Return Duct Leakage Only

Cooling Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment Factor, Cooling, design	1		
For Duct Thermal Mass Correction, Enter F for flex duct or duct board, M for sheet metal	M		Equipment Factor, cooling, seasonal	#DIV/0!		
For equipment efficiency correction, Enter 1 for ACCA manual D design, 2 without Manual D design	1					
Enter 1 for single speed cooling equipment, 2 for multispeed cooling equipment						
Enter 1 for single speed heating equipment, 2 for multispeed heating equipment	1	A heat pump with strip heat is a variable capacity piece of equipment				
For Vented Attic, Enter V for vented, U for unvented	V					
For cooling systems, Enter T for TXV control, O for other control	O					
For heating systems, Enter H for heat pump, O for other system	O					
Supply plenum dry bulb temperature for cooling systems, [F]						
Number of return Registers	3					
OUTPUT PARAMETERS						
Delivery Effectiveness			**Distribution System Efficiency**			
Heating, design	**0.35**		**Heating, design**	**0.71**		
Heating, seasonal	**0.37**		**Heating, seasonal**	**0.67**		
Cooling, design	**#DIV/0!**		**Cooling, design**	**#DIV/0!**		
Cooling, seasonal	**#DIV/0!**		**Cooling, seasonal**	**#DIV/0!**		

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152 Calculation - Duct Configuration #5; Supply and Return Duct Leakage Sealed, Supply Ducts Insulated

Draft ASHRAE standard 152 duct efficiency calculations						
Aug-97						
INPUT PARAMETERS			CALCULATED PARAMETERS			
	Value used in calculation	**Notes**				
Conditioned floor area, (ft^2)	2216		Heating seasonal temperature	18.0		
Supply Duct Surface Area, (ft^2)	380		Cooling Seasonal temperature	-16.0		
Return Duct Surface Area, (ft^2)	488		Ground Temperature for basements	1.0		
Fraction of supply duct in attic	0		Fraction of supply duct outside conditioned space	0.8		
Fraction of supply duct in garage	0		Fraction of return duct outside conditioned space	0.9		
Fraction of supply duct in unvented & uninsulated crawlspace	0		Design Supply Duct Zone temperature, Heating, (F)	21.3	Design Temp. diff for supply, dTs, heating	46.7
Fraction of supply duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Seasonal Supply Duct Zone temperature, Heating, (F)	24.5	Seasonal Temp. diff for supply, dTs, heating	43.5
Fraction of supply duct in unvented crawlspace with insulated building floor	0		Limited Design Return Duct Zone temperature, Heating, (C)	22.0	Design Temp. diff for return, dTr, heating	46.0
Fraction of supply duct in Vented & uninsulated crawlspace	0		Limited Seasonal Return Duct Zone temperature, Heating, (C)	25.4	Seasonal Temp. diff for return, dTr, heating	42.6
Fraction of supply duct in Vented crawlspace with insulated building floor and crawlspace walls	0		Design Supply Duct Zone temperature, Cooling, (F)	0.5	Design Temp. diff for supply, dTs, cooling	-0.5

152 Calculation - Duct Configuration #5; Supply and Return Duct Leakage Sealed, Supply Ducts Insulated

Fraction of supply duct in Vented crawlspace with insulated building floor	0		Seasonal Supply Duct Zone temperature, Cooling, (F)	-2.7	Seasonal Temp. diff for supply, dTs, cooling	2.7
Fraction of supply duct in uninsulated basement	0.79		Limited Design Return Duct Zone temperature, Cooling, (C)	0.5	Design Temp. diff for return, dTr, cooling	-0.5
Fraction of supply duct in basement with insulated walls	0		Limited Seasonal Return Duct Zone temperature, Cooling, (C)	-9.5	Seasonal Temp. diff for return, dTr, cooling	9.5
Fraction of supply duct in basement with insulated ceiling	0		Design Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	1		
Fraction of supply duct under slab	0		Seasonal Supply Duct Zone Enthalpy, Cooling, (Btu/lb)	0		
Fraction of supply duct in exterior walls	0		Limited Design Return Duct Zone Enthalpy, Cooling, (J/Kg)	1		
Fraction of return duct in attic	0		Limited Seasonal Return Duct Zone Enthalpy, Cooling, (J/Kg)	-2		
Fraction of return duct in garage	0		Fcycloss	0.04		
Fraction of return duct in unvented & uninsulated crawlspace	0		Fflow, heating	1		
Fraction of return duct in unvented crawlspace with insulated building floor and crawlspace walls	0		Fflow,cooling,TXV	1		
Fraction of return duct in unvented crawlspace with insulated building floor	0		Fflow,cooling,non-TXV	1		
Fraction of return duct in Vented & uninsulated crawlspace	0.048					
Fraction of return duct in Vented crawlspace with insulated building floor and crawlspace walls	0					
Fraction of return duct in Vented crawlspace with insulated building floor	0		Supply Duct Thermal regain	0.50	System Thermal regain	0.50
Fraction of return duct in uninsulated basement	0.887		Return Duct Thermal regain	0.50		

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152 Calculation - Duct Configuration #5; Supply and Return Duct Leakage Sealed, Supply Ducts Insulated

Fraction of return duct in basement with insulated walls	0		Infiltration, Fan off, (cfm)	114	LOW SPEED	
Fraction of return duct in basement with insulated ceiling	0		Heating as	0.800272	Heating as	#DIV/0!
Fraction of return duct under slab	0		Heating, ar	0.881793	Heating, ar	#DIV/0!
Fraction of return duct in exterior walls	0		Cooling as	#DIV/0!	Cooling as	#DIV/0!
Supply Duct R value (hft^2F/Btu)	5.03		Cooling ar	#DIV/0!	Cooling ar	#DIV/0!
Return Duct R value (hft^2F/Btu)	1		Temperature change across heat exchanger, dTe, heating	141.69		
Indoor Temperature, heating (F)	68		Temperature change across heat exchanger, dTe, heating, low capacity	#DIV/0!		
Indoor Temperature, cooling (F)			Temperature change across heat exchanger, dTe, cooling	#DIV/0!		
Heating Design temperature, ASHRAE 97.5%, (F)	2		Temperature change across heat exchanger, dTe, cooling, low capacity	#DIV/0!	LOW SPEED	
Cooling Design temperature, ASHRAE, 2.5%, (F)			Heating, Bs	0.93	Heating, Bs	#DIV/0!
T wetbulb design, (F)			Heating, Br	0.56	Heating, Br	#DIV/0!
T wetbulb indoor, (F)			Cooling, Bs	#DIV/0!	Cooling, Bs	#DIV/0!
Is there solar gain reduction in the attic? [Y/N]	N		Cooling, Br	#DIV/0!	Cooling, Br	#DIV/0!
House Volume, (ft^3)	19612	default is 8.2feetxFloor Area	Imbalance Flow, Heating, (cfm)	60	Imbalance Flow, Heating, (cfm)	0
Equipment Heating Capacity, [Btu/hour]	112,627	Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here	Imbalance Flow, Cooling, (cfm)	0	Imbalance Flow, Cooling, (cfm)	0
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number)		Enter single speed equipment capacity here. For two speed equipment, enter higher capacity here				

152 Calculation - Duct Configuration #5; Supply and Return Duct Leakage Sealed, Supply Ducts Insulated

Equipment Heating Capacity, [Btu/hour], LOW		For two speed equipment, enter lower capacity here				
Equipment Cooling Capacity, [Btu/hour] (this should be entered as a negative number), LOW		For two speed equipment, enter lower capacity here				
Heating Fan Flow, (cfm)	736	For two speed equipment, enter higher flow here				
Cooling Fan Flow, (cfm)		For two speed equipment, enter higher flow here				
Heating Supply duct leakage (cfm)	147	For two speed equipment, enter higher flow here				
Heating Return duct leakage (cfm)	87	For two speed equipment, enter higher flow here	Net building infiltration, heating, (cfm)	145.3484	Net building infiltration, heating, (cfm)	117.1469
Cooling Supply duct leakage (cfm)		For two speed equipment, enter higher flow here	Net building infiltration, cooling, (cfm)	117.1469	Net building infiltration, cooling, (cfm)	117.1469
Cooling Return duct leakage (cfm)		For two speed equipment, enter higher flow here	Load Factor, heating, design	0.981	Recovery Factor, heating, design	1.317
Heating Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, heating, seasonal	0.943	Recovery Factor, heating, seasonal	1.304
Cooling Fan Flow, (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, design	#DIV/0!	Recovery Factor, cooling, design	#DIV/0!
Heating Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Load Factor, cooling, seasonal	#DIV/0!	Recovery Factor, cooling, seasonal	#DIV/0!
Heating Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, design	1		
Cooling Supply duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment factor, heating, seasonal	1		

152 Calculation - Duct Configuration #5; Supply and Return Duct Leakage Sealed, Supply Ducts Insulated

Cooling Return duct leakage (cfm), LOW SPEED		For two speed equipment, enter lower flow here	Equipment Factor, Cooling, design	1		
For Duct Thermal Mass Correction, Enter F for flex duct or duct board, M for sheet metal	M		Equipment Factor, cooling, seasonal	#DIV/0!		
For equipment efficiency correction, Enter 1 for ACCA manual D design, 2 without Manual D design	1					
Enter 1 for single speed cooling equipment, 2 for multispeed cooling equipment						
Enter 1 for single speed heating equipment, 2 for multispeed heating equipment	1	A heat pump with strip heat is a variable capacity piece of equipment				
For Vented Attic, Enter V for vented, U for unvented	V					
For cooling systems, Enter T for TXV control, O for other control	O					
For heating systems, Enter H for heat pump, O for other system	O					
Supply plenum dry bulb temperature for cooling systems, [F]						
Number of return Registers	3					
OUTPUT PARAMETERS						
Delivery Effectiveness			**Distribution System Efficiency**			
Heating, design	**0.60**		**Heating, design**	**0.78**		
Heating, seasonal	**0.61**		**Heating, seasonal**	**0.75**		
Cooling, design	**#DIV/0!**		**Cooling, design**	**#DIV/0!**		
Cooling, seasonal	**#DIV/0!**		**Cooling, seasonal**	**#DIV/0!**		