Air Cleaning Conference

Cincinnati, Ohio

July 2006

Building Inertia Effect on Ventilation Cooling

What is this mean?

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Southern Nuclear

Building Inertia Effect on Ventilation Cooling

ASHRAE 1999 Application Chapter on Nuclear Facilities: Outside Conditions: Reads

“For some applications, such as diesel generator buildings or safety related pump houses in nuclear power plants, 24 h averages suffice”

Building Inertia Effect on Ventilation Cooling

The Section in '**2003 Application Handbook**' was changed to '….., the 24 hr average temperature may be used as a steady value. For critical ventilation system design the site meteorological data should be evaluated'

Building Inertia Effect on Ventilation Cooling

Most plants are designed based on the temperature of
ASHRAE Fundamental – Weather Data

Sources:

Weather Data obtained from:

- National Climatic Data Center of NOAA
- US Air Force
- US Navy
- Canadian Atmospheric Environment service

Building Inertia Effect on Ventilation Cooling

Old design (Prior to 1997 ASHRAE Fundamental)

Summer Design Values:

1%(30 hrs); 2.5%; 5% (150 hrs) (have equaled or exceeded the temperature in the month of June through September (a total of 2928 hour) in the Northern Hemisphere and December through March (a total of 2904 hr) for the Southern Hemisphere; For Canada, the values are only for July.

Winter Design Values:

99%; 97.5% (have equaled or exceeded the temperature in the month of December, January and February (a total of 2160 hour)

Building Inertia Effect on Ventilation Cooling

ASHRAE Fundamental Chapter 24

Table 1 Climatic Conditions for the United States

Col. 1	Col. 2	Col. 3	Col. 4	Winter,[b] °F Col. 5		Summer,[c] °F Col. 6			Col. 7	Col. 8			Prevailing Wind Col. 9			Temp., °F Col. 10	
State and Station[a]	Lat.	Long.	Elev.	Design Dry-Bulb		Design Dry-Bulb and Mean Coincident Wet-Bulb			Mean Daily Range	Design Wet-Bulb			Winter		Summer	Median of Annual Extr.	
	° 'N	° 'W	Feet	99%	97.5%	1%	2.5%	5%		1%	2.5%	5%	Knots[d]			Max.	Min.
ALABAMA																	
Alexander City	32 57	85 57	660	18	22	96/77	93/76	91/76	21	79	78	78					
Anniston AP	33 35	85 51	599	18	22	97/77	94/76	92/76	21	79	78	78	SW	5	SW	98.4	12.4
Auburn	32 36	85 30	652	18	22	96/77	93/76	91/76	21	79	78	78				99.8	14.6
Birmingham AP	33 34	86 45	620	17	21	96/74	94/75	92/74	21	78	77	76	NNW	8	WNW	98.5	12.9
Decatur	34 37	86 59	580	11	16	95/75	93/74	91/74	22	78	77	76					
Dothan AP	31 19	85 27	374	23	27	94/76	92/76	91/76	20	80	79	78					
Florence AP	34 48	87 40	581	17	21	97/74	94/74	92/74	22	78	77	76	NW	7	NW		
Gadsden	34 01	86 00	554	16	20	96/75	94/75	92/74	22	78	77	76	NNW	8	WNW		
Huntsville AP	34 42	86 35	606	11	16	95/75	93/74	91/74	23	78	77	76	N	9	SW		
Mobile AP	30 41	88 15	211	25	29	95/77	93/77	91/76	18	80	79	78	N	10	N		
Mobile Co	30 40	88 15	211	25	29	95/77	93/77	91/76	16	80	79	78				97.9	22.3
Montgomery AP	32 23	86 22	169	22	25	96/76	95/76	93/76	21	79	79	78	NW	7	W	98.9	18.2
Selma, Craig AFB	32 20	87 59	166	22	26	97/78	95/77	93/77	21	81	80	79	N	9	SW	100.1	17.6
Talladega	33 27	86 06	565	18	22	97/77	94/76	92/76	21	79	78	78				99.6	11.2
Tuscaloosa AP	33 13	87 37	169	20	23	98/75	96/76	94/76	22	79	78	77	N	5	WNW		

Building Inertia Effect on Ventilation Cooling

New design (1997 and 2001 ASHRAE Fundamental)

Summer Design Values:

0.4%(30 hrs); 1% (88 hrs), 2% (175hrs) for the total of 8760 annual hrs

Winter Design Values:

99.6% (35 hrs); 99% (88 hrs) for the total of 8760 annual hrs

Current Table provides:

Extreme Wind speeds; Wind direction; Extreme temperatures

Building Inertia Effect on Ventilation Cooling

ASHRAE Fundamental Chapter 26

Table 1A Heating and Wind Design Conditions—United States

Station	WMO#	Lat.	Long.	Elev. ft	StdP psia	Dates	Heating DB		Extreme Wind Speed			Coldest Month WS/MDB				MWS/MWD to DB				Annual Extreme Daily			
												0.4%		1%		99.6%		0.4%		Mean DB		StdD DB	
							99.6%	99%	1%	2.5%	5%	WS	MDB	WS	MDB	MWS	PWD	MWS	PWD	Max	Min	Max	Min
ALABAMA																							
Anniston	722287	33.58	85.85	610	14.374	8293	19	24	16	14	13	18	47	15	46	6	300	7	240	98	10	3.2	7.4
Birmingham	722280	33.57	86.75	630	14.364	6193	18	23	19	17	15	20	41	18	42	7	340	9	320	98	9	3.3	6.4
Dothan	722268	31.32	85.45	400	14.484	8293	28	32	18	17	15	19	45	17	47	9	320	8	320	99	16	1.6	7.2
Huntsville	723230	34.65	86.77	643	14.357	6193	15	20	23	20	18	23	40	21	40	10	340	10	270	97	7	3.0	7.5
Mobile	722230	30.68	88.25	220	14.579	6193	26	30	22	19	17	23	48	21	48	10	360	9	320	97	18	1.9	6.3
Montgomery	722260	32.30	86.40	203	14.588	6193	24	27	20	17	15	20	45	18	45	7	360	8	270	98	15	2.9	6.3
Muscle Shoals/Florence	723235	34.75	87.62	551	14.405	8293	16	21	18	16	14	19	42	17	42	9	360	7	290	98	7	3.1	9.2
Ozark, Fort Rucker	722269	31.28	85.72	299	14.538	8293	28	31	16	13	12	17	49	15	47	5	340	5	300	99	18	2.3	5.9
Tuscaloosa	722286	33.22	87.62	171	14.605	8293	20	24	17	14	13	18	47	16	51	5	360	7	240	99	11	1.8	6.8
ALASKA																							
Adak, NAS	704540	51.88	176.65	13	14.688	8293	19	23	34	30	27	40	34	34	35	4	210	10	170	67	11	3.4	2.9
Anchorage, Elemendorf AFB	702720	61.25	149.80	213	14.583	8293	−13	−8	17	14	12	18	26	15	26	3	50	7	260	77	−18	3.2	6.5
Anchorage, Fort Richardson	702700	61.27	149.65	377	14.496	8293	−19	−13	19	14	11	20	35	15	36	3	50	5	270	80	−23	2.2	6.3
Anchorage, Int'l Airport	702730	61.17	150.02	131	14.626	6193	−14	−9	22	19	17	23	18	19	18	4	10	8	290	77	−18	2.9	7.2
Annette	703980	55.03	131.57	112	14.636	6193	13	17	31	27	23	31	41	28	40	10	40	8	320	81	10	3.8	5.4

Building Inertia Effect on Ventilation Cooling

ASHRAE Fundamental Chapter 26

Table 1B Cooling and Dehumidification Design Conditions—United States

Station	Cooling DB/MWB						WB/MDB						DP/MDB and HR									Range of DB
	0.4%		1%		2%		0.4%		1%		2%		0.4%			1%			2%			
	DB	MWB	DB	MWB	DB	MWB	WB	MDB	WB	MDB	WB	MDB	DP	HR	MDB	DP	HR	MDB	DP	HR	MCDB	
ALABAMA																						
Anniston	95	76	93	76	90	75	79	90	78	88	77	86	77	143	84	76	137	82	75	133	81	19.6
Birmingham	94	75	92	75	90	74	78	89	77	88	76	87	75	135	83	74	131	82	73	127	81	18.7
Dothan	95	76	93	76	92	76	80	90	79	88	78	87	77	144	83	76	139	82	76	136	82	17.5
Huntsville	94	75	92	74	90	74	78	89	77	88	76	86	75	135	83	74	130	82	73	126	81	18.5
Mobile	94	77	92	76	91	76	79	89	79	88	78	87	77	142	83	76	139	83	76	135	82	16.5
Montgomery	95	76	93	76	91	76	79	91	78	89	78	88	76	139	85	75	134	84	75	130	83	18.7
Muscle Shoals/Florence	96	76	94	75	92	74	78	90	78	89	77	87	76	137	82	75	133	82	74	130	81	20.0
Ozark, Fort Rucker	95	77	94	77	92	76	81	90	79	89	78	88	78	146	85	77	142	84	76	138	83	18.0
Tuscaloosa	95	77	94	77	92	76	80	90	79	89	78	88	77	142	84	76	137	83	75	134	82	19.6
ALASKA																						
Adak, NAS	59	55	57	53	55	51	55	59	53	57	51	54	53	59	58	51	55	56	49	51	53	9.7
Anchorage, Elemendorf AFB	71	58	69	57	66	56	60	69	58	66	57	64	57	69	62	55	65	61	53	61	60	12.6
Anchorage, Fort Richardson	74	60	71	58	68	57	61	72	59	69	58	66	56	69	64	54	63	62	53	61	61	15.5
Anchorage, Int'l Airport	71	59	68	57	65	56	60	69	58	66	57	63	56	68	62	55	64	61	53	61	60	12.6
Annette	74	61	70	59	66	57	62	72	60	68	58	65	58	71	65	56	68	63	55	65	61	10.5
Barrow	57	51	52	49	48	46	52	56	49	52	46	48	49	53	54	46	46	51	44	42	48	10.6
Bethel	72	59	68	57	64	55	60	69	58	66	56	63	56	68	62	55	64	60	53	60	58	13.4
Bettles	79	61	75	59	72	58	63	76	61	73	59	70	58	72	66	56	67	64	54	63	63	19.4
Big Delta, Ft. Greely	78	59	75	58	71	56	61	74	59	72	58	69	56	70	65	54	65	63	52	61	61	17.3

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LER at Clinton citing Diesel Generator Ventilation System design does not meet extreme design temperature limit.

Building Inertia Effect on Ventilation Cooling

<u>Common Ventilation System Design</u>:

Let the calculated heat load be Q

Common ‘ventilated’ area design temperature:

- Tied to the electrical equipment rating of 40°C or 104°F
- Tied to the electrical equipment rating of 50°C or 122°F

Supposed the outside air design temperature is 95°F

Ventilation Air requirement: $Q/(\rho \times C_p \times 60 \times \Delta T)$

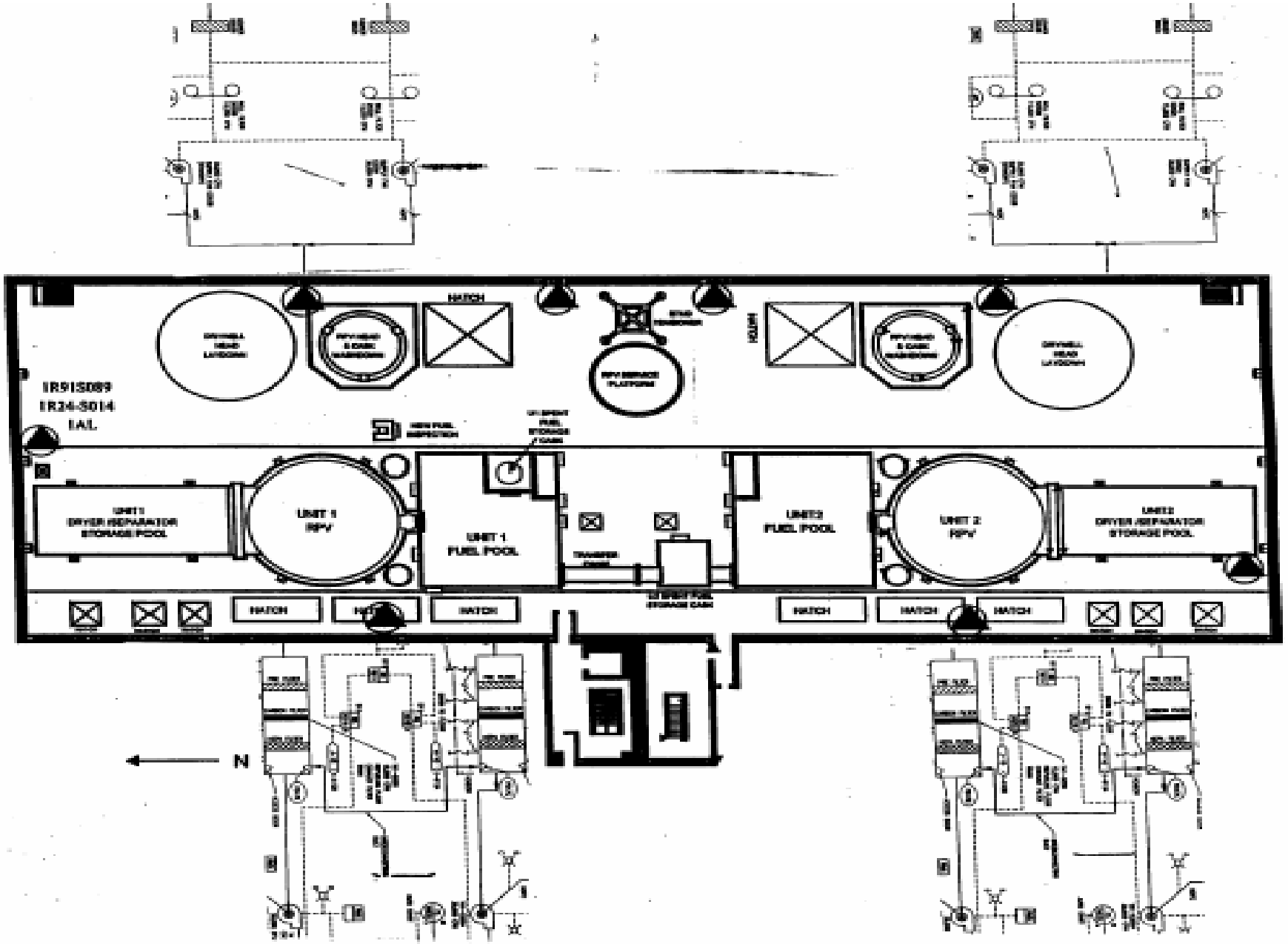
For $\rho = 0.075$; $C_p = 0.24$; Usually $\Delta T = (104 - 95)$

Ventilation Air requirement: $Q/(1.08 \times \Delta T)$

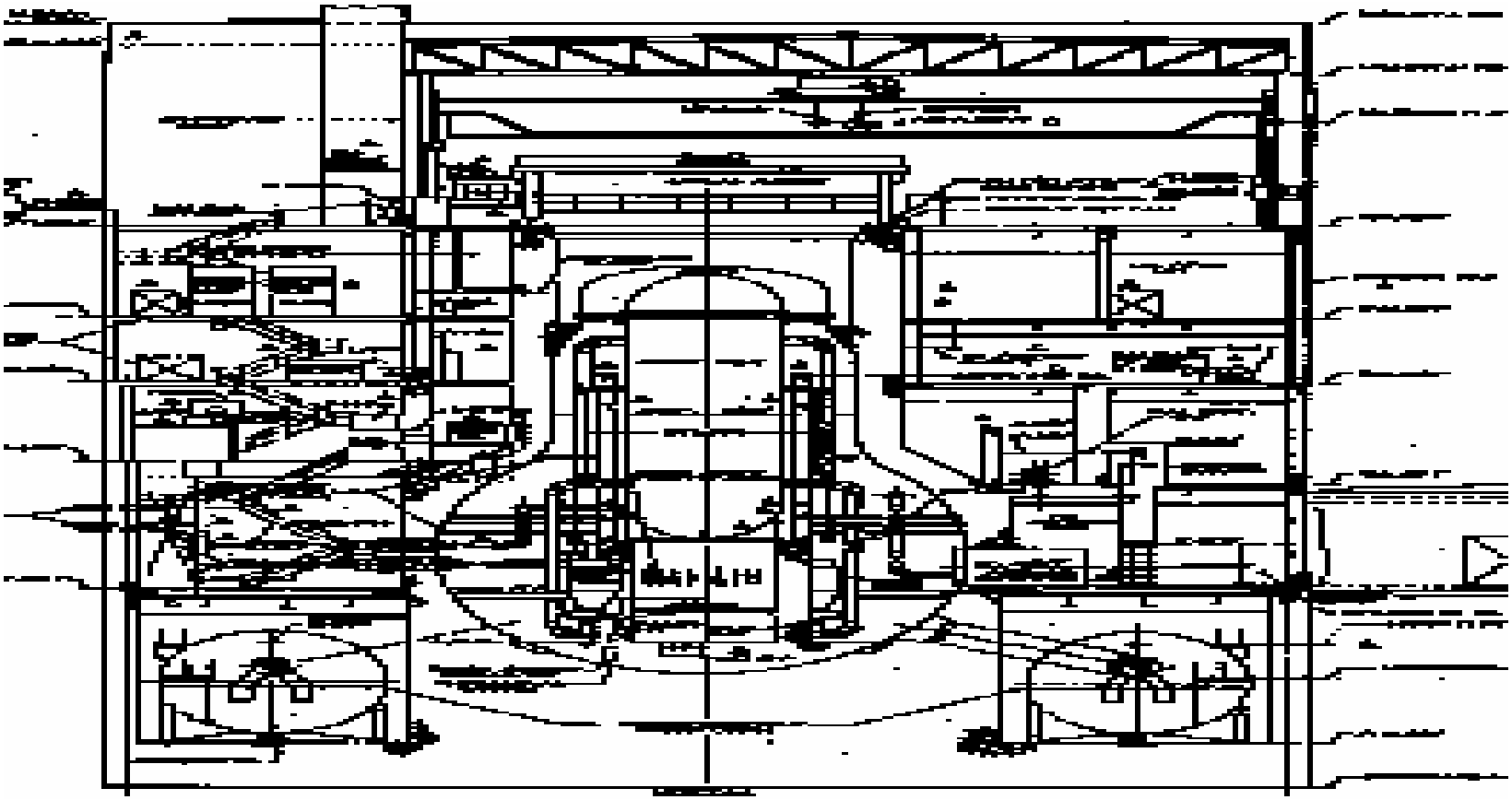
Building Inertia Effect on Ventilation Cooling

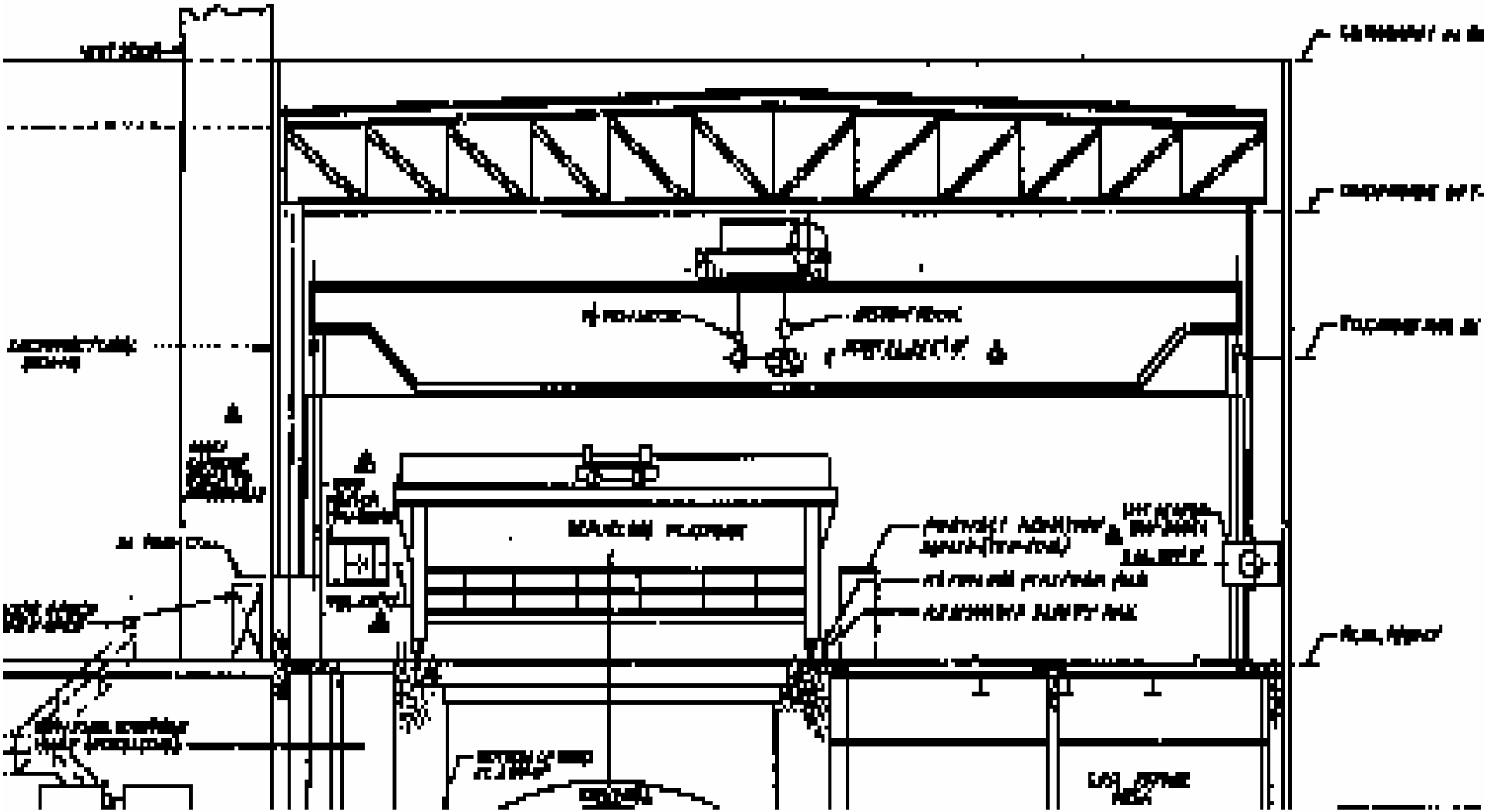
The outside air temperature may vary 15-25°F, during the day, but does that mean the room temperature will vary by that amount?

Building Inertia Effect on Ventilation Cooling



RX Bldg General Arrangement





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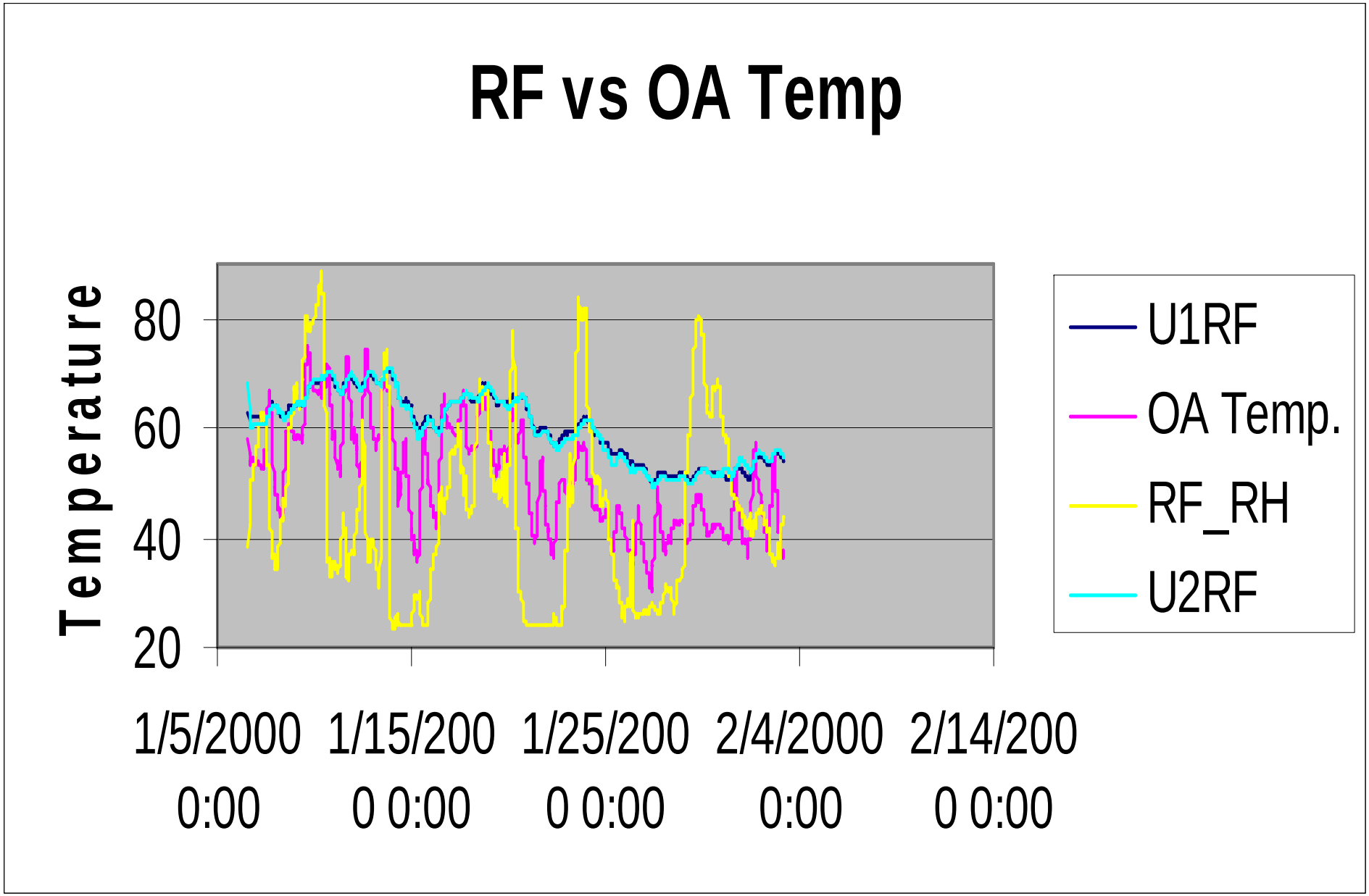

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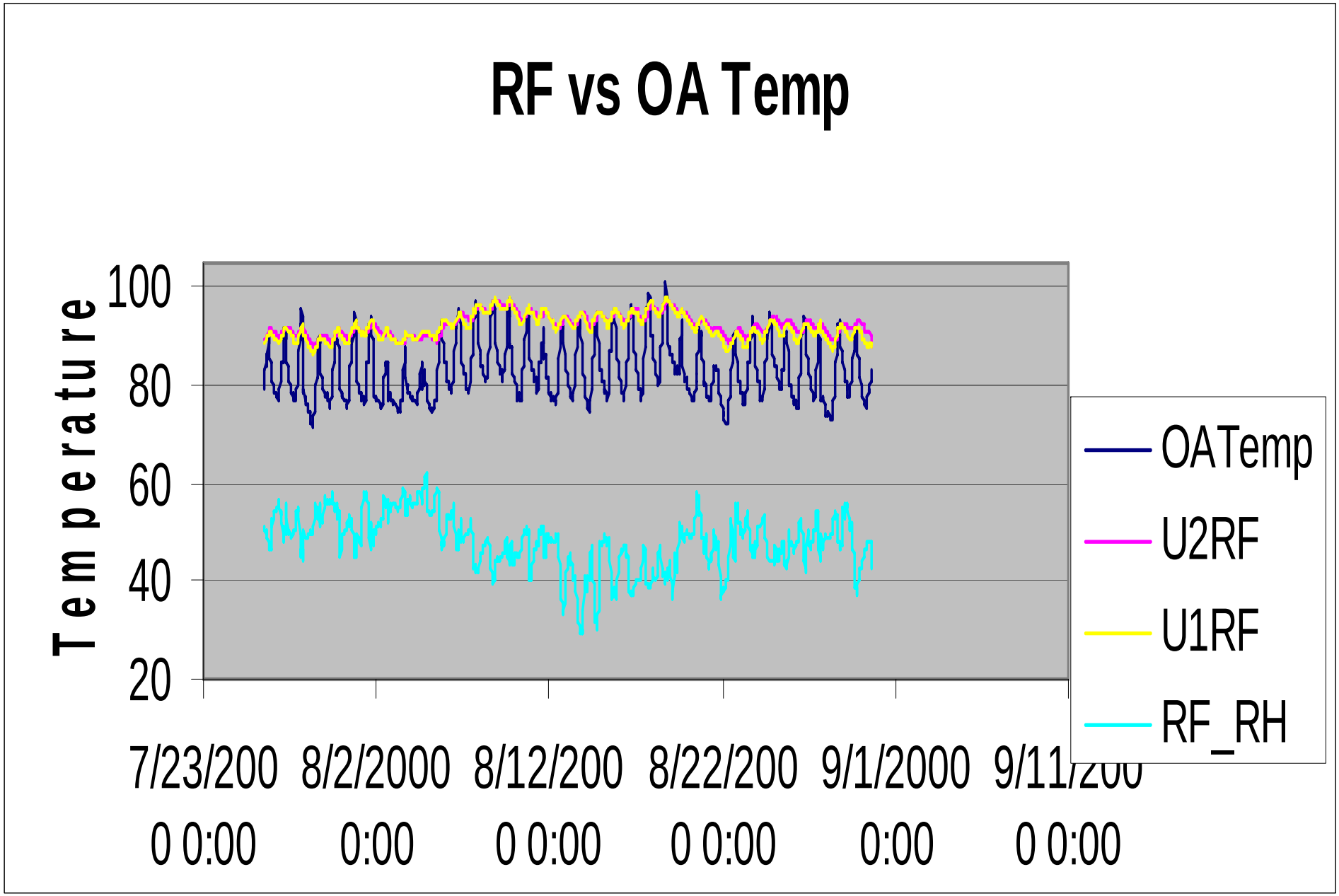
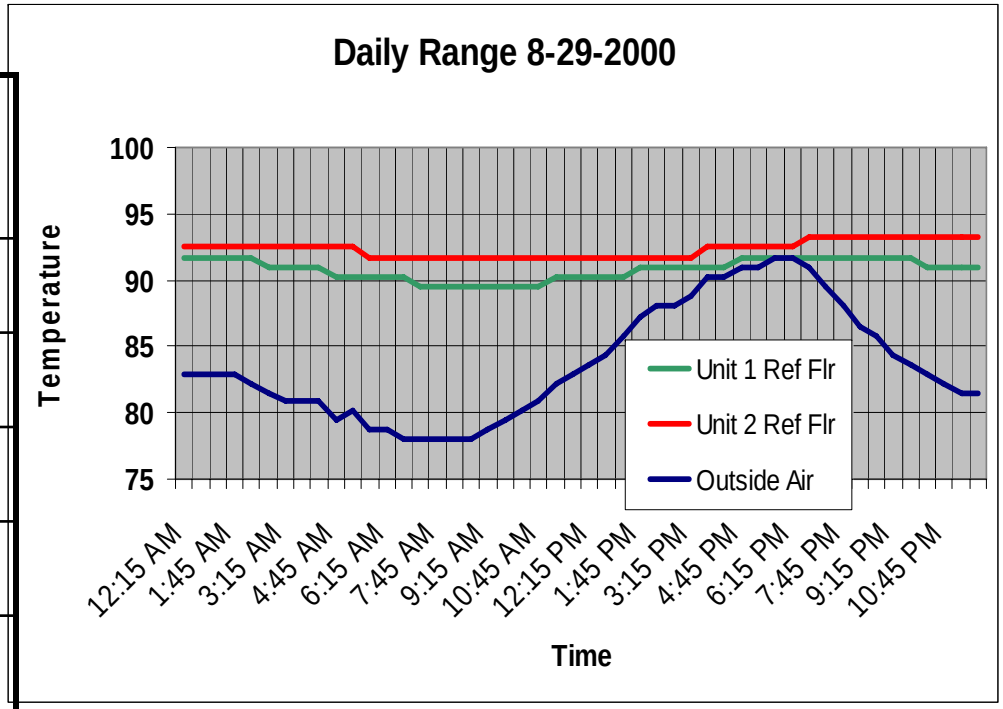


Building Inertia Effect on Ventilation Cooling

24 hours average

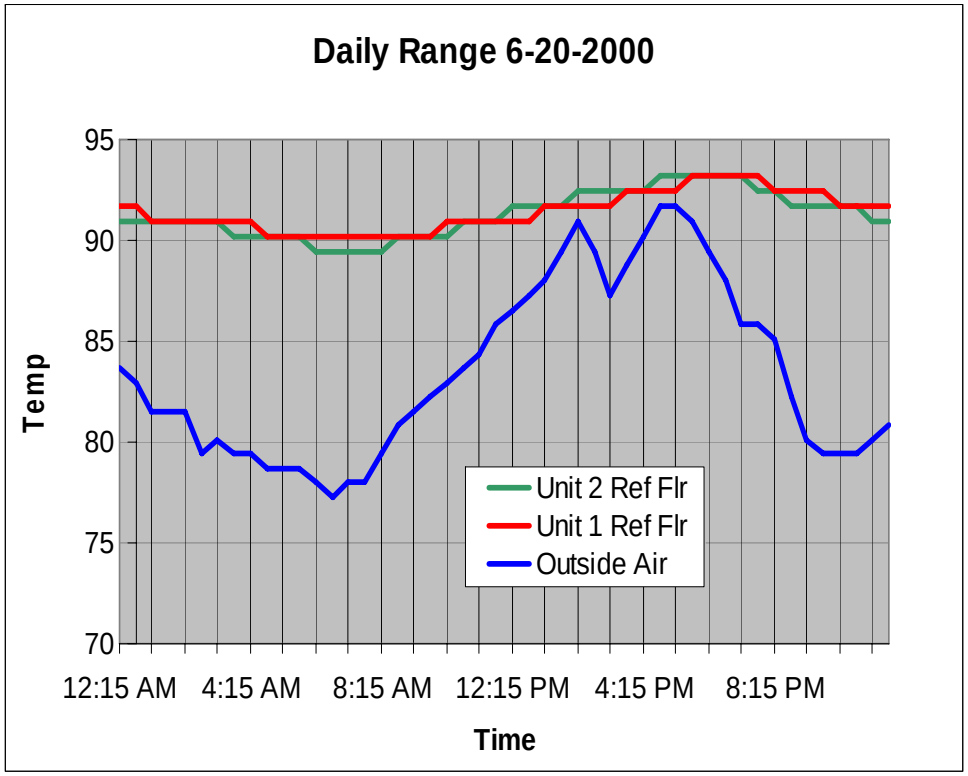
	Unit 1	Unit 2	Outside Air
Avg	90.8	92.3	83.7
Max	91.7	93.2	91.7
Min	89.5	91.7	78.0
Variation	2.2	1.5	13.7
Delta T (Tavg-Toa)	7.1	8.6	



Building Inertia Effect on Ventilation Cooling

24 hours average

	Unit 1	Unit 2	Outside Air
Avg	91.3	91.5	83.5
Max	93.2	93.2	91.7
Min	89.5	90.2	77.1
Variation	3.70	3.0	14.60
Delta T (Tavg-Toa)	7.8	8.0	



Building Inertia Effect on Ventilation Cooling

Question:

The outside air temperature may vary 15-25°F, during the day, but does that mean the room temperature will vary by that amount?

Answer: NO

There is a thermal lag between the Outside Air Temperature and the Area Temperature. The Area Temperature may only between 2-5 ° F for a 15-20°F Outside Air Temperature variation provided the heat generation rate in the area remain unchanged.

Building Inertia Effect on Ventilation Cooling

Conclusion:

- The building's thermal inertia effect prevents the area temperature to linearly track the outside air temperature. The area temperature may only change by about 2-5°F for a 15-20°F variation in outside air temperature

- Ventilation systems designed using 1% weather design value in the ASHRAE Fundamental is acceptable for all safety related systems.

- Ventilation systems designed using the 2.5% weather design value in the ASHRAE Fundamental is acceptable for all noncritical and nonsafety related systems.