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Study by Michael Kjelgaard

“June 2003: a Year in Review; ASHRAE Design conditions vs. 2002 – Weather Report”

June 2003: a year in review: Ashrae design conditions vs. 2002 - weather report

Michael Kjelgaard

The end of June '03 marks the second anniversary for the "Weather Report", and I would like to thank all of you who have volunteered your $.02 along the way. The feedback has been very helpful in our effort to achieve our dual goal of becoming a dependable weather data resource as well as a good source for useful and practical "hands on" HVAC systems design and operational information. So keep those e-mails coming. Also, note that the monthly data table (Figure 1) has been modified to reflect only cooling related data since we are now well into summer, and it just didn't make sense to waste space by reporting a bunch of zeroes. Heating related values will be reinstalled When fall comes around again.

We never got around to taking a look back at the totals for 2002, so now is as good a time as any, and I thought it would be a good idea to start with ASHRAE design conditions. To recap, the ASHRAE design outdoor air conditions are published in the 1997 ASHRAE Fundamentals Handbook for 1,459 locations around the world. These values are used to determine required heating and cooling equipment capacities for HVAC systems and other energy related processes. The 0.4%, 1.0%, and 2.0% design values for outside air dry bulb and wet bulb temperatures represent the temperatures that are exceeded 0.4%, 1.0% and 2.0% of the year on average, or 35, 88, and 175 hours per year respectively. Similarly, the outside air dry bulb temperature is less than the heating 99.6% and 99% design values 35 and 88 hours per year respectively.

Figures 2 and 3 indicate that the '02 cooling season was very demanding on air conditioning systems all over the country. The expected 35, 88, and 175 hours for design dry bulb and wet bulb values were exceeded many times over in many locations with the exception of western cities. In some cases, the design wet bulb hours were off the chart. In Miami, there were 775 hours above 2.0% design. That's almost 4.5 times the average of 175 hours!

Higher wet bulb temperatures mean higher cooling ventilation loads. And as some of you have experienced, if the wet bulb temperature is continuously greater than the temperature that a cooling tower was sized for, it could be load-shedding time. Wet bulb temperature is very volatile year to year, and sometimes it's a good idea to take a look at some actual data when designing a ventilation system or selecting a cooling tower, especially in critical design applications.

On the heating side (Figure 4), the number of hours below the heating design values were lower than normal pretty much across the country. Not quite what I expected to see, given what seemed to be a long winter. Note however that Figure 4 reflects the '02 calendar year and does not include the early '03 winter months.

Figure 1

	Degree Days (Base 65 F)				Dry Bulb Temperature			
June 2003	HDD	N	CDD	N	Max Deg F	N	Min Deg F	N
Atlanta	0	1	275	354	87	94	56	57
Baltimore	31	10	172	243	92	95	45	49
Boston	77	48	85	143	89	93	50	50

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Chicago	71	48	86	160	92	93	38	43
Cleveland	52	50	107	152	90	92	41	43
Dallas	0	0	424	492	94	99	60	60
Denver	110	55	26	131	86	95	40	42
Detroit	51	46	105	140	90	92	42	44
Houston	0	0	517	485	97	97	67	62
Los Angeles	8	22	16	52	73	82	59	55
Memphis	0	0	289	425	92	96	56	58
Miami	0	0	520	500	91	93	73	70
Minneapolis	30	47	117	146	88	93	49	44
New York City	40	13	159	222	95	93	51	52
Philadelphia	25	11	202	232	95	94	53	50
Phoenix	0	0	812	688	112	112	72	62
Salt Lake City	26	52	196	167	98	98	34	42
San Diego	33	12	15	66	73	82	59	57
San Francisco	146	125	31	19	96	88	50	48
St. Louis	25	6	199	321	91	96	49	52
Seattle	117	152	49	21	90	85	48	45
Washington, DC	15	4	203	301	92	95	53	54

June 2003	Wet Bulb Deg F		Hum. Ratio Grains / Lb		Enthalpy Btu / Lb	
	Max	Min	Max	Min	Max	Min
Atlanta	78	53	146.7	52.0	41.9	22.0
Baltimore	77	43	127.8	36.4	39.9	16.5
Boston	79	46	136.1	28.3	42.4	17.9
Chicago	75	37	105.8	21.8	37.9	13.7
Cleveland	77	39	121.6	30.6	40.2	15.0
Dallas	80	60	139.4	67.7	44.2	26.7
Denver	65	40	111.1	27.7	35.9	16.2
Detroit	77	40	124.8	25.7	40.5	15.1
Houston	83	66	161.9	64.8	46.3	31.1
Los Angeles	65	57	81.3	61.8	30.0	24.0
Memphis	79	55	132.4	58.7	41.8	23.4
Miami	81	71	156.0	86.4	44.6	34.5
Minneapolis	78	45	135.2	30.0	41.9	17.8
New York City	78	47	119.3	34.3	40.6	18.7
Philadelphia	78	47	141.2	32.3	41.6	18.6
Phoenix	70	49	62.4	12.9	35.2	20.0
Salt Lake City	62	42	72.2	11.5	29.3	10.2
San Diego	66	56	86.2	53.2	30.6	23.5
San Francisco	67	43	86.3	10.6	31.1	16.5
St. Louis	79	48	129.7	35.8	42.5	19.0
Seattle	68	47	80.1	23.0	31.8	18.3
Washington, DC	76	46	126.5	34.0	39.5	18.2

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June 2003	VLIc Sensible Ton-hr / cfm		VLIc Latent Ton-hr / cfm		VLIc Total Ton-hr / cfm	
	Jun	N	Jun	N	Jun	N
Atlanta	1.23	1.32	1.23	0.86	2.46	2.17
Baltimore	0.95	1.14	0.75	0.83	1.70	1.97
Boston	0.66	0.77	0.53	0.31	1.19	1.07
Chicago	0.75	0.98	0.19	0.45	0.94	1.43
Cleveland	0.80	0.95	0.41	0.59	1.21	1.55
Dallas	1.53	1.63	1.62	1.26	3.15	2.90
Denver	0.48	0.70	0.02	0.00	0.50	0.71
Detroit	0.80	0.89	0.30	0.43	1.10	1.32
Houston	1.73	1.61	2.38	1.91	4.11	3.52
Los Angeles	0.58	0.57	0.29	0.23	0.87	0.79
Memphis	1.30	1.54	1.15	1.45	2.45	2.99
Miami	1.74	1.69	2.62	2.05	4.36	3.74
Minneapolis	0.87	0.91	0.27	0.47	1.14	1.38
New York City	0.89	1.06	0.56	0.37	1.44	1.42
Philadelphia	1.06	1.04	0.92	0.65	1.98	1.70
Phoenix	2.43	2.27	0.00	0.01	2.34	2.29
Salt Lake City	1.11	0.86	0.00	0.00	1.11	0.86
San Diego	0.55	0.78	0.24	0.28	0.78	1.06
San Francisco	0.41	0.28	0.02	0.01	0.42	0.29
St. Louis	1.09	1.30	0.69	1.33	1.78	2.63
Seattle	0.52	0.35	0.01	0.01	0.53	0.36
Washington, DC	1.03	0.98	0.85	0.84	1.87	1.82

1.) GENERAL--Derived from raw data furnished by the National Weather Service (NWS). Normal values (N) are from the historical record provided by the National Climatic Data Center (NCDC). Normal values for VLI were derived from the TMY2 data set compiled by the National Renewable Energy Laboratory using the 2003 calender for equal number of weekdays. Based on 24 Hr operation.

2.) COOLING VENTILATION LOAD INDEX's (VLIc)--Sensible, latent and total energy required per cfm of outdoor air to maintain 55 F discharge air temperature. VLIc in Ton-hfs / cfm. Calculated hourly, Based on 24 hr operation.

FIGURE 2.

2002 A SHRAE Cooling Design Hours

	0.4%	1.0%	2.0%
BAL	80	158	305
BOS	68	197	310

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CHI	37	125	229
CLE	74	192	310
DAL	0	0	24
DEN	61	171	323
DET	67	182	331
HOU	7	57	167
LA	13	34	72
MEM	5	26	98
MIA	5	25	100
MIN	20	86	192
NYC	92	198	371
PHIL	122	255	357
PHX	22	85	223
SLC	88	142	220
SD	5	17	40
SF	36	78	152
STL	44	94	261
SEA	26	65	129
DC	47	152	323

FIGURE 3.

2002 A SHRAE Wet Bulb Design Hours

	0.4%	1.0%	2.0%
BAL	49	187	290
BOS	102	148	317
CHI	74	187	270
CLE	48	173	479
DAL	24	178	411
DEN	12	100	213
DET	43	141	236
HOU	40	201	201
LA	1	4	18
MEM	8	54	103
MIA	157	410	775
MIN	84	227	452
NYC	96	197	318
PHIL	33	94	329
PHX	0	4	22
SLC	20	47	130
SD	0	0	0
SF	89	148	226
STL	25	60	297
SEA	48	72	192
DC	44	89	276

FIGURE 4.

2002 A SHRAE Heating Design Hours

	99.6%	99.0%
BAL	4	9
BOS	0	0
CHI	0	8
CLE	0	0
DAL	3	40
DEN	0	19
DET	0	11
HOU	21	63
LA	9	34
MEM	0	14
MIA	10	44
MIN	0	0
NYC	2	2
PHIL	4	4
PHX	5	5
SLC	9	35
SD	30	73
SF	5	22
STL	0	4
SEA	9	11
DC	2	4

Note: Table made from a bar graph.