ASHRAE Climatic Data Activities

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ASHRAE

- American Society of Heating Refrigerating and Air-Conditioning Engineers
- >50,000 members
- Major products:
  - Handbooks (Fundamentals, Systems and Equipment, Refrigeration, Applications)
  - Standards
- More than 100 Technical Committees and Standards Committees composed of volunteers who write the handbooks, standards, and manage research projects.
- Climatic data required for ASHRAE member’s use is created in TC 4.2 and SSPC 169.
ASHRAE Technical Committee 4.2
Climatic Information

Scope:

TC 4.2 is concerned with identification, analysis and tabulation of climatic data for use in analysis and design of heating, refrigeration, ventilation and air-conditioning systems. Promotion of effective use of weather information in these applications is also included.

Committee members include meteorologists, data suppliers and users (engineers, energy simulation)
TC 4.2 Major Products

• Chapter 14 ASHRAE 2009 Handbook Fundamentals which Climatic Design Conditions for more than 5,500 locations throughout the world.

• Recent research projects (competitive solicitation):
  – New climatic design conditions for 2013 Handbook
  – International Weather data for Energy Calculations (more than 3200 ‘typical’ hourly data files for use in energy simulation – all outside US and Canada)
  – Macroclimatic – regional models
  – Data filling for sparse data sets
Standing Standards Project Committee 169
Weather Data for Building Design Standards

• **PURPOSE:** This standard provides recognized weather data for use in building-design and related equipment standards.

• **SCOPE:**
  – This standard covers weather data used in ASHRAE standards, including dry-bulb, dew-point and wet-bulb temperatures, enthalpy, humidity ratio, wind conditions, solar irradiation, latitude, longitude, and elevation for locations worldwide.
  – This standard also includes statistical data such as mean temperatures, average temperatures, mean/median annual extremes, daily ranges, heating and cooling degree days and degree hours, and hours and seasonal percentages within ranges of temperatures as well as bins.

• **Publications:**
  – Major update under way to incorporate new data from 2009 Handbook and other sources
• Climatic Design Conditions are at the core of TC 4.2 and Standard 169

• These data are calculated for 20-30 years of weather conditions

• Primary data source is the National Climatic Data Center, which houses a WMO data repository for the entire world
  - Integrated Surface Hourly 1986-2010
  - Stations in all countries (including Canada and USA)

• Stations in Canada: GRP118 Data Set 1986-2010
Simple design conditions

• $x\%$ design condition = ‘cond. exceeded $x\%$ of time’
• Annual design conditions
  – 99.6% and 99% heating dry bulb temperature,
  – 0.4%, 1% and 2% cooling dry bulb temperature,
  – 0.4%, 1% and 2% evaporation wet bulb temperature,
  – 0.4%, 1% and 2% dehumidification dew point temperature,
  – *99.6% and *99% humidification dew point temperature,
  – *0.4%, *1% and *2% enthalpy.
• Monthly design conditions
  – 0.4% and 1% wind speed for the coldest month,
  – 0.4%, 1% and 2% dry bulb temperature for all months,
  – 0.4%, 1% and 2% wet bulb temperature for all months.
Calculation: simple conditions

• Data read from original file
• Outliers eliminated
• Time series filled by linear interpolation
  (dry bulb & dew point temperatures only)
• Months included in the analysis only if complete enough
• Data sorted by bins to create *frequency vector*
• Frequency vector summed to calculate *cumulative frequency distribution function*
• Example: 2% cooling dry bulb temperature
  Atlanta, GA, for the month of August
Coincident design conditions

• Annual design conditions
  – mean wet bulb temperature coincident with the 0.4%, 1% and 2% yearly cooling dry bulb temperatures;
  – mean wind speed coincident with the 99.6% and 0.4% yearly dry bulb temperatures;
  – etc...

• Monthly design conditions
  – mean wet bulb temperature coincident with the 0.4%, 1% and 2% dry bulb temperatures, for all months;
  – etc...
2% cooling dry bulb: 92.8 °F
Other elements calculated

- Coldest and Hottest Months
- Mean and Standard Deviation of Extreme Annual Dry Bulb Temperature
- Monthly Mean Daily Dry Bulb Temperature Range
- Extreme Maximum Wet Bulb Temperature
- Degree days to any base
- Clear sky irradiance
2009 ASHRAE Climatic Design Conditions - Station Finder

Zoom in to a particular area to make the markers corresponding to the stations appear, or type the name of the location in the Location box.
2009 ASHRAE Climatic Design Conditions - Station Finder

Zoom in to a particular area to make the markers corresponding to the stations appear, or type the name of the location in the Location box.

Location: Atlanta, GA
2009 ASHRAE Climatic Design Conditions - Station Finder

Zoom in to a particular area to make the markers corresponding to the stations appear, or type the name of the location in the Location box.

Location: Atlanta, GA

ATLANTA HARTSFIELD INTL AP, GA, USA
WMO id: 722190
Lat: 33.64N
Long: 84.43W
Elev: 313m / 1027ft

View design conditions (SI)
View design conditions (IP)
ATLANTA HARTSFIELD INTL AP, GA, USA

Annual Heating and Humidification Design Conditions

<table>
<thead>
<tr>
<th>Coldest Month</th>
<th>Heating DB</th>
<th>Humidification DP/MCDB and HR</th>
<th>Coldest month WS/MCDB</th>
<th>MCWS/PCWD to 99.6% DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-6.3</td>
<td>-3.5</td>
<td>-15.8</td>
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Annual Cooling, Dehumidification, and Enthalpy Design Conditions

<table>
<thead>
<tr>
<th>Hottest Month</th>
<th>Hottest Month DB Range</th>
<th>Cooling DB/MCWB</th>
<th>Evaporation WB/MCDB</th>
<th>MCWS/PCWD to 0.4% DB</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>9.5</td>
<td>34.4</td>
<td>23.5</td>
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Extreme Annual Design Conditions

<table>
<thead>
<tr>
<th>Extreme Annual WS</th>
<th>Extreme Max WB</th>
<th>Extreme Annual DB</th>
<th>n=5 years</th>
<th>n=10 years</th>
<th>n=20 years</th>
<th>n=50 years</th>
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<tbody>
<tr>
<td>9.8</td>
<td>8.6</td>
<td>7.7</td>
<td>-11.2</td>
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<td>-22.1</td>
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Monthly Climatic Design Conditions

<table>
<thead>
<tr>
<th>Temperatures, Degree-Days and Degree-Hours</th>
<th>Annual</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td>Tavg</td>
<td>17.0</td>
<td>6.6</td>
<td>8.8</td>
<td>12.6</td>
<td>16.6</td>
<td>21.2</td>
<td>24.8</td>
<td>26.7</td>
<td>26.2</td>
<td>22.9</td>
<td>17.5</td>
<td>12.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Std</td>
<td>5.5</td>
<td>3.5</td>
<td>4.5</td>
<td>5.0</td>
<td>4.3</td>
<td>3.4</td>
<td>2.5</td>
<td>1.8</td>
<td>2.0</td>
<td>1.8</td>
<td>3.4</td>
<td>4.6</td>
<td>5.2</td>
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<tr>
<td>HDD10.0</td>
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<td>97</td>
<td>72</td>
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<td>30</td>
<td>107</td>
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<td>HDD18.3</td>
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<td>97</td>
<td>81</td>
<td>40</td>
<td>8</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>8</td>
<td>63</td>
<td>331</td>
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<td>55</td>
<td>61</td>
<td>4</td>
<td>203</td>
<td>348</td>
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<td>519</td>
<td>501</td>
<td>386</td>
<td>234</td>
<td>101</td>
<td>34</td>
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<td>2196</td>
<td>1030</td>
<td>196</td>
<td>18</td>
<td>1</td>
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<tr>
<td>Yearly</td>
<td>Heating Degree Days</td>
<td>Cooling Degree Days</td>
<td>Heating Degree Hours</td>
<td>Cooling Degree Hours</td>
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<tr>
<td>2016</td>
<td>3000</td>
<td>1000</td>
<td>8000</td>
<td>5000</td>
<td></td>
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<tr>
<td>2017</td>
<td>2500</td>
<td>1200</td>
<td>7500</td>
<td>4500</td>
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<td>2018</td>
<td>2800</td>
<td>1100</td>
<td>8200</td>
<td>4800</td>
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</tbody>
</table>

*Note: Values are approximate and subject to change.*
The changing climate

• Climatic design conditions have changed significantly over the last few decades; this reflects a warming of the climate
• Cooling DB increases at same rate as average temperature, heating DB increases faster
• Cause may be combination of global warming and Urban Heat Island Effect
• Be cautious when using of a shorter, more recent period of record to capture climatic trends, as it may introduce uncertainties bigger than the trends themselves
\[ \Delta DB^{99.6} = DB_{1997-2006}^{99.6} - DB_{1977-1986}^{99.6} \]

Difference in 99.6% Heating Dry Bulb Temperature (°F)

Average: 1.52°C / 2.74°F
### Average changes per decade, last ‘30 years’

<table>
<thead>
<tr>
<th>Description</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>99.6% heating dry bulb temperature</td>
<td>+ 0.76</td>
<td>+ 1.37</td>
</tr>
<tr>
<td>0.4% cooling dry bulb temperature</td>
<td>+ 0.38</td>
<td>+ 0.68</td>
</tr>
<tr>
<td>0.4% dehum. dew point temperature</td>
<td>+ 0.28</td>
<td>+ 0.50</td>
</tr>
<tr>
<td>Dry bulb temperature range</td>
<td>~ 0</td>
<td>~ 0</td>
</tr>
<tr>
<td>Average temperature</td>
<td>+ 0.41</td>
<td>+ 0.73</td>
</tr>
<tr>
<td>Heating degree-days base 18.3°C / 65°F</td>
<td>- 118</td>
<td>- 212</td>
</tr>
<tr>
<td>Cooling degree-days base 10°C / 50°F</td>
<td>+ 68</td>
<td>+ 122</td>
</tr>
</tbody>
</table>
TC 4.2 and SSPC 169 Resources

• TC 4.2:
  – Chapter 14 Climatic Design Conditions, ASHRAE 2009 Handbook Fundamentals
  – TC 4.2 Chair: Didier Thevenard, DThevenard@numlog.com

• Standard 169:
  – SSPC 169 Chair: Dru Crawley, Dru.Crawley@bentley.com