UC Davis Western Cooling Challenge Program Requirements

Program Overview

The Western Cooling Challenge (WCC), hosted by the Western Cooling Efficiency Center (WCEC) at the University of California Davis, is a multiple winner competition that encourages HVAC manufactures to develop climate-appropriate rooftop packaged air conditioning equipment that will reduce electrical demand and energy use in Western climates by at least 40% compared to DOE 2010 standards.

The program was developed at the behest of commercial building owners and investor-owned utilities who would like to see the success of such technologies in the market place. Their interest in the Challenge is motivated by state and corporate goals for energy efficiency and sustainability. For example, the California Public Utility Commission's Energy Efficiency Strategic Plan gives specific priority to the application of climate-appropriate cooling technologies such as those that have been developed for the Cooling Challenge.

The intent of the Challenge is to push beyond prototype demonstration of high efficiency cooling equipment by advancing the market introduction of commercialized equipment. Participants in the Challenge must submit market available products, and must consider the many non-technical design factors that impact success of a commercial product.

Laboratory testing and data analysis will be performed by or under the observation of the WCEC. Costs for laboratory testing will be covered by WCEC and partners, though participants must commit to provide equipment and cooperative support to WCEC and partners as needed.

WCC certification of equipment will be granted to entries that meet all requirements and performance criteria as determined through laboratory testing, but test results for one configuration will not necessarily qualify units with other capacities and configurations, and major revisions to system components after testing may disqualify certification. Beyond laboratory testing, WCEC will work to conduct demonstrations and field evaluation of certified equipment. Additionally, WCEC will advocate for utility programs and participate in other activities to support the market introduction of successful technologies.

Non-Performance Based Requirements

In addition to the criteria for energy and water use efficiency under specific operating conditions, the following non-performance based requirements apply for WCC certification:

1. Entries must be roof-top package unit (RTU) systems, with nominal cooling capacity[1] of 3-30 tons. An entry need not span the entire capacity range.
2. Participants must demonstrate the capacity to produce 500 units per year, and the equipment tested must be commercially available for purchase.
3. Entries shall have under-voltage protection that prevents grid connection in a stalled condition.
4. On-board electronics shall have the capability to communicate significant performance degradation.

Operating Conditions for Certification

Laboratory tests to qualify an entry will be conducted according to the following conditions:

	WCC Peak Conditions	WCC Annual Conditions
Outside Air Condition *Tdb°F/Twb°F*	105/73	90/64
Return Air Condition *Tdb°F/Twb°F*	78/64	78/64
Minimum Outdoor Ventilation [2] *cfm/nominal-ton*	120	120
External Resistance[3] *In WC at 350 cfm/nominal-ton*	0.7	0.7
Min Filtration	MERV 7	MERV 7
Operating Mode	Full Capacity	Full Capacity or Part Capacity[4]

Performance Requirements

The following performance criteria must be achieved in laboratory tests to qualify an entry for Western Cooling Challenge certification:

	WCC Peak Conditions	WCC Annual Conditions
Min Sensible Credited Capacity *(% sensible credited cooling at peak conditions)*[5]	NA	80%
Min Sensible Credited EER *(kbtu/kWh)*[6]	14	17
Max Supply Air Humidity *(lb/lb)*	.0092	.0092
Max Water Use *(gal/ ton-h)*[7]	NA	4

Calculation of Performance Metrics

Along with other metrics, equations 1-6 will be used to characterize performance of the equipment:

$$\dot{H}_{space} = \dot{m}_{SA} \cdot (h_{RA} - h_{SA}) \quad (1)$$

$$\dot{H}_{ventilation} = \dot{m}_{SA} \cdot \big((OAF \cdot h_{OA} + (1 - OAF) \cdot h_{RA}) - h_{RA}\big) \quad (2)$$

$$\dot{H}_{credited\ ventilation} = \dot{m}_{SA} \cdot \left(\left(\frac{120 \cdot nominal\ capacity}{\dot{V}_{SA}} \cdot h_{OA} + \left(1 - \frac{120 \cdot nominal\ capacity}{\dot{V}_{SA}}\right) \cdot h_{RA}\right) - h_{RA}\right) \quad (4)$$

$$\dot{H}_{system} = \dot{H}_{space} + \dot{H}_{ventilation} \quad (3)$$

$$\dot{H}_{credited} = \dot{H}_{space} + \dot{H}_{credited\ ventilation} \quad (5)$$

$$\dot{H}_{nominal} = \dot{m}_{SA} \cdot (h_{RA}^{AHRI} - h_{SA}^{WCC\ Peak}) \quad (6)$$

where:

$\dot{H}$ = Cooling capacity (*kbtu/h*)

Δh = Specific cooling capacity (*btu/lb dry air*), where $\Delta h = \frac{\dot{H}}{\dot{V}_{SA} \cdot \rho_{SA}}$

$\dot{m}$ = Mass flow rate (*lb dry air/min*)

h = Specific enthalpy (*btu/lb dry air*), where h = 0 at 0°F

OAF = Outdoor air fraction

and the subscripts for each variable are defined by:

SA = Supply air

RA = Return air or indoor air

OA = Outside air

The following psychrometric chart illustrates the capacity metrics used to characterize performance of WCC equipment, where each total capacity is normalized by the supply air flow rate such that $\dot{H}_i = \dot{m}_{SA} \cdot \Delta h_i$. Note that for certain machines the "mixed air" condition may be a hypothetical value determined by a theoretical mixture of outdoor air and return air needed to achieve a particular outdoor air fraction.

A. Δh_{space}

B. $\Delta h_{ventilation}$

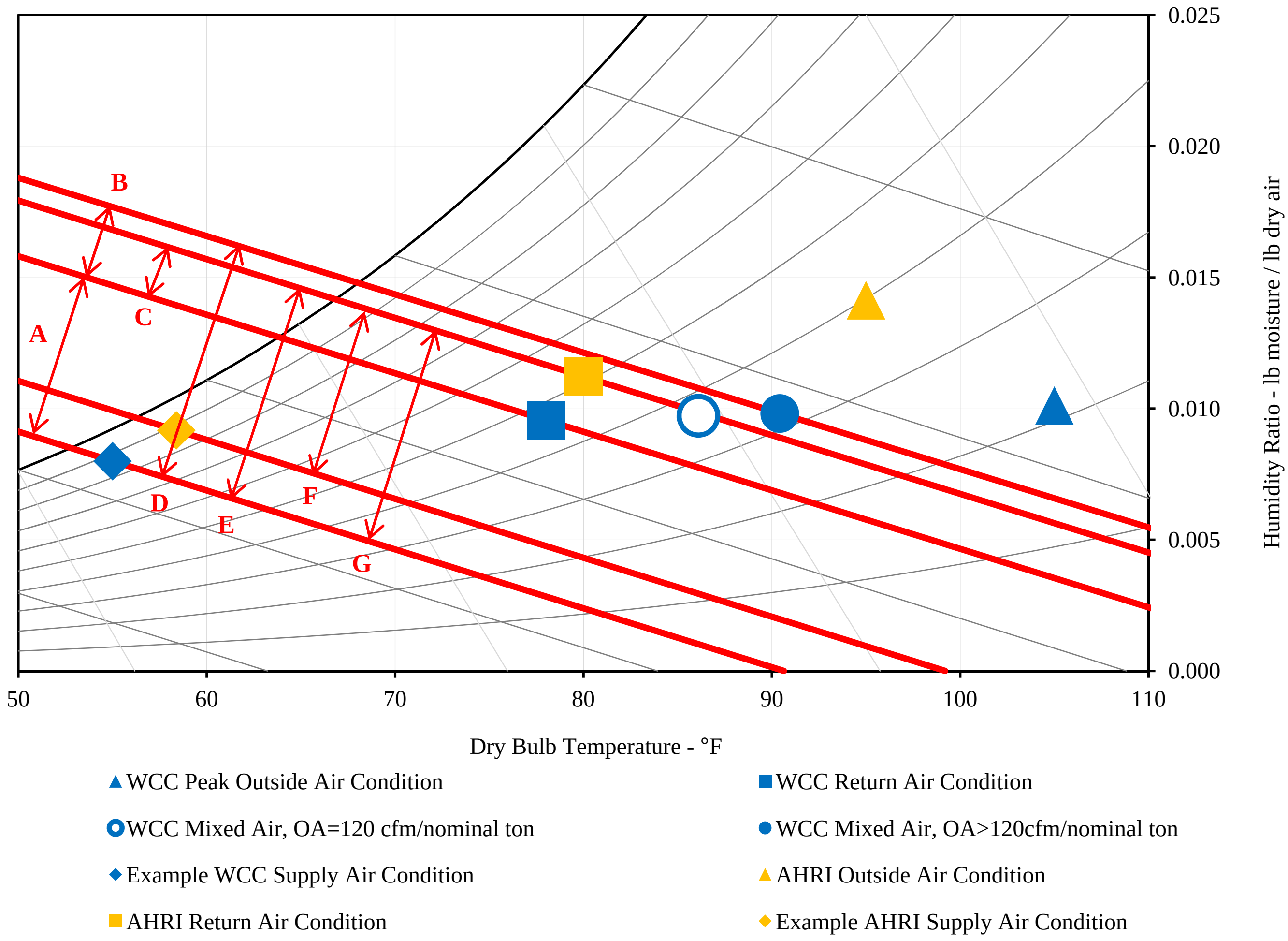
C. $\Delta h_{creditedventilation}$

D. Δh_{system}

E. $\Delta h_{credited}$

F. $\Delta h_{AHRI\text{-}nominal}$

G. $\Delta h_{nominal}$



Contact Information

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Notes

[1] Nominal cooling capacity is determined by equation 6 while at full-load operation, under WCC Peak conditions, with the minimum possible, or minimum required outdoor air fraction

[2] For equipment that has a higher minimum ventilation rate than 120 *cfm/nominal-ton*, tests will be conducted with the minimum outdoor air fraction. The credited cooling capacity metric, described by equation 5, accounts for the additional capacity from cooling of excess outdoor air.

[3] External static to be measured as differential static pressure between supply and return plenum, with MERV 7 filtration in place. For systems that supply more or less than 350 *cfm/nominal-ton*, the external static pressure for tests will be adjusted to match the same external resistance according to:

$$ESP_{test}\,\{InWC\} = \left(\frac{V_{SA}\left\{\frac{cfm}{nominalton}\right\}}{350\left\{\frac{cfm}{nominalton}\right\}}\right)^2 \cdot 0.7\,\{InWC\}$$

[4] For WCC annual conditions, results for qualification may be determined by one of two options:

A. Operation at full capacity
B. Linear interpolation to hypothetical performance at sensible credited cooling of 80% of the sensible credited cooling achieved by full capacity operation for WCC Peak conditions, based on results for:
    1. Operation at full capacity
    2. Continuous partial-capacity operation

[5] Sensible credited capacity is the sensible portion of the credited capacity described by equation 5

[6] Electric power used to calculate EER will include all parasitics (e.g.: blowers, fans, pumps, controls)

[7] Water use is calculated specific to the sensible credited cooling capacity, and includes all on-site water demand by the system, including any bleed or purge water use during steady state operation for water hardness of 200 ppm (as $CaCO_3$).