Discussions for the Technical Papers from the 2015 ASHRAE Annual Conference in Atlanta, Georgia

This is a compilation of the written questions and comments submitted to authors by attendees at the 2015 ASHRAE Annual Conference in Atlanta, Georgia. All authors were given the opportunity to respond.

The questions/comments and authors' responses are published with the papers in the hardbound volume of *ASHRAE Transactions*, Vol. 121, Part 2.

AT-15-001

2014 Update to Climatic Data for Energy Standards Criteria Development: Part 1—CDD and HDD Baseline Values

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DISCUSSION

Michael Sullivan, GSA-PBS, Chesapeake, VA: GSA is attempting to correlate energy consumption to HDD/CDD to indicate why a particular building might be seeing an energy increase. Does a building balance point play in the energy consumption and how can the CDD/HDD be used to determine the proper number of hours to apply HDD and CDD so an estimate of percent increase in either of them can be applied to the increase/decrease in kWh or Btu to Btu/ft^2/yr analysis?

John Hogan: This paper addresses CDD and HDD baseline values as used in developing energy standards for climate zones that, as shown in Table 1, have a broad range of CDD and HDD values. It uses long-term average CDD and HDD values and does not address year-to-year fluctuations. The companion paper, AT-15-002, "2014 Update to Climatic Data for Energy Standards Criteria Development: Part 2—Representative Weather Files," cites analyses of the same prototype building by PNNL using different weather files in the same climate zone showing that "a 6% difference in CDD10°C (CDD50°F) in a cooling-dominated climate (Climate Zone [CZ] 2) resulted in an 11% difference in energy consumption for space heating and space cooling, and that a 17% difference in HDD18°C (HDD65°F) in a heating-dominated climate (CZ 8) resulted in a 21% difference in energy consumption for space heating and space cooling." However, the impacts on building energy consumption of year-to-year fluctuations in CDD and HDD values will vary depending on a number of factors. The 2013 ASHRAE Handbook—Fundamentals, Chapter 19, "Energy Estimating and Modeling Methods," lists advantages and limitations for a variety of methodologies and specifically addresses CDD and HDD and balance points. See the "annual degree-day method" (pages 19.16–19.19) for more information.

AT-15-003

A New Clustering Method to Identify Outliers and Diurnal Schedules from Building Energy Interval Data

Saurabh Jalori *Affiliate Member ASHRAE*
T. Agami Reddy, PhD, PE *Fellow ASHRAE*

DISCUSSION

Radu Zmeureanu, Professor, Concordia University, Montreal, Canada: Is there any conflict between the selection of minimum number points within each cluster and the value of epsilon that indicates the distance between those clusters?

T. Agami Reddy: We would not call it a "conflict," but both of these criteria are interlinked to some extent. Increasing the number of data points will generally require higher values of epsilon, but the exact degree would depend on the specific data set. As is common in statistics (for example, determining outlier points in regression), there is some arbitrariness and the analyst has to make some tentative evaluations on a few pertinent data sets in order to come up with some specific values. This would also depend on the objective of the analysis. Having more clusters is not necessarily advisable because this could lead to instability (and false negatives), while having too few clusters reduces the resolution of the analysis (i.e., likely to have false positives).

AT-15-004

A History of the Changing Concepts on Health-Care Ventilation

Travis R. English, PE *Member ASHRAE*
Daniel Koenigshofer, PE *Member ASHRAE, HFDP*

DISCUSSION

Michael Deru, NREL, Golden, CO: What is the correlation between particulate levels and infection control? Why do you monitor PM?

Travis English: Measuring PM (or particles), particularly during commissioning, is a practical way to ensure working filter systems. In several European countries (for example, the United Kingdom and Germany), "filter challenge" testing is required for operating rooms (ORs). The authors are not aware of many U.S. hospitals monitoring PM, yet. However, the advent of affordable, real-time particle sensing may change that. We have seen a small handful of examples of real-time particle monitoring in ORs in the U.S. and abroad.

For the most part, we don't know there is a correlation between particle levels and infections. The evidence in ORs is discussed in the body of the paper. For the remainder of spaces, there isn't a body of evidence to draw conclusions from. One exception: in protective environments for immunocompromised patients (e.g., neutropedic patients, transplant recipients), bacterial contamination (above 1 cfu/m^3) has been cited as harmful in clinical literature. While PM measurement is not a direct measurement of bacterial contamination, it may serve as an effective proxy.

Since the 1960s in the United States, there has been a strong emphasis on filtration and filtered air. Many U.S. engineers see filtered air as vital to patient care. By contrast, several European countries favor operable windows. In the close of this paper, we authors state our plea for an objective indoor air quality standard for health care spaces.

AT-15-005

Plug and Process Loads in Medical Office Buildings

Ross Ruecker *Associate Member ASHRAE*
Arash Guity, PE *Associate Member ASHRAE*
Jun Timbang, PE

DISCUSSION

Abdel Darwich, Associate Principal, Guttmann & Blaevoet, Sacramento, CA: Will the study publish actual schedule graphs to help better estimate actual energy consumption?

Larry Spielvogel, Consulting Engineer, Bala Cynwyd, PA: Section 1.2 of the referenced IEEE Standard 241-1990 says, "Medical areas are covered in IEEE Std 602-1986, IEEE Recommended Practice for Electric Systems in Health Care Facilities (ANSI) [10] (the "White Book")." It is also not noted that the IEEE Standard has not been revised or updated in 25 years, nor is it ANSI approved any longer.

The authors do not mention or reference the extensive plug and process load data in the ASHRAE Handbook, ASHRAE research, and other ASHRAE publications.

While the paper consistently expresses loads in watts, the author in his presentation said all measurements were made in amps. The paper does not contain any description of the instruments used or their accuracy.

While peak loads are mentioned in the paper, there is no mention of the duration or time of the peak loads or whether they coincided with the building peak loads.

In 2008, the chairman of the IEEE IAS Standards Department at http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4623745 said there is a "major project underway to reorganize" these IEEE standards. Nothing since has been published on this subject.

Caution is urged when trying to use the data in this paper for buildings in other locations or by other owners or occupants.

AT-15-014

An Economic Analysis of Conventional and Heat Pump Heating and Cooling Systems in the DOE Prototypical Elementary School Building in Various Climatic Zones

William Ryan, PhD, PE **Marek Czachorski**
Member ASHRAE

DISCUSSION

Ben Akinbohun, Department of Defense, Army National Guard, Arlington, VA: 1) It appears that the life-cycle cost and payback period for GSHP should be reexamined. 2) If you assume 50 years life cycle for GSHP in comparison to 25 years for the traditional units, e.g., rooftop, boiler and chiller, etc., will that make a difference of the economic benefit of GSHP? 3) Since the study considers using multiple zones, what happens to the units in the zone not occupied?

Marek Czachorski: 2) Only underground piping can theoretically last 50 years, but little is known about long-term performance degradation. All other components of GSHP last 15 to 25 years maximum. 3) In occupied zones, units control temperature per unoccupied/setback temperature schedules.

William Ryan: 1) Economic evaluations are presented in the paper in great detail. Why do they need to be reexamined? 2) I agree with Marek's comments and note that ASHRAE's expected lifetimes for small-capacity heat pump equipment, such as the indoor units used in ground-source and water-source heat pump systems (Systems 2 and 3), are generally well under 20 years and they often require compressor replacements in shorter periods. This maintenance cost has not been included in the paybacks, as much the same maintenance will be required for the rooftops unit (System 1), which was the baseline for the payback evaluation. Underground piping will last much longer. Equipment lifetime will not affect the payback calculation itself. However, when payback periods exceed a practical equipment lifetime as seen in some of our results, the payback period is effectively "never." 3) Local units in all systems cycle to meet the local loads. Each of the zones had an occupation and setback schedule.

AT-15-021

Estimating Daily Domestic Hot-Water Use in North American Homes

Danny S. Parker **Philip Fairey** *Member ASHRAE* **James D. Lutz, PE** *Member ASHRAE*

DISCUSSION

Jeff Haberl, Professor, Texas A&M University, College Station, TX: I was wondering if your study considered the type of plumbing hot-water distribution systems, as it impacts energy waste during warm-up. For example, is there less loss with manifold PEX piping versus copper in the slab?

Philip Fairey: This study did not consider any energy impacts because of differences between the types of piping used in hot-water distribution systems.

AT-15-022

Evaluation of Airflow Measurement Methods for Residential HVAC Returns

Iain Walker, PhD **J. Chris Stratton**
Fellow ASHRAE

DISCUSSION

Muhammad Tauha Ali, Research Engineer, Masdar Institute of Science and Technology, Masdar City, Abu Dhabi: 1) Can you please explain the method used for correcting the leaks/error in the apparatus measuring airflow? 2) Why was thermal dispersion/hot wire technology not tested when measuring airflow through traversing ducts?

Iain Walker: 1) We sealed the system and characterized its air leakage as a function of pressure. During testing, we measured the pressure difference between the apparatus and the room to determine the air leakage. The flows through the in-line flow meter then had the leakage flows subtracted as these leakage flows came through leaks and not through the grilles. These corrections were small (on the order of 1%). 2) We were not traversing ducts—we were measuring airflows at grilles. This is primarily because ducts are inaccessible for traversing and they very rarely have sufficient length without changes for traverse assumptions to be true.

Russ Johnson, Johnson Research, Pueblo West, CO: Do you have any suggestions for continuous airflow measurement (logging data) in a residential HVAC installation (returns may be partially blocked, return into air handler may be short, etc.)?

Walker: You could use the duct system itself. If you measure the pressure difference between the supply (or return) plenum and the living space and measure the airflow one time, then you can log the pressure differences with a simple pressure logger. You can then convert the measured pressure changes into airflow changes by assuming the flow is proportional to the square root of pressure.

AT-15-024

Identification and Elimination of Hunting Behavior in HVAC Systems

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Christopher Price
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Shuangshuang Liang, PhD

Bryan Rasmussen, PhD, PE
Member ASHRAE

DISCUSSION

Amber Buhl, Engineer, CLEAResult, Portland, OR: What is the usefulness of the cascade control loop solution to existing buildings to reduce hunting behavior?

Rohit Chintala: HVAC systems are highly nonlinear. Using traditional PI control for nonlinear systems with varying operating conditions is the most likely cause of hunting. Cascaded control loop architecture helps reduce the nonlinearity present in the system. A comprehensive description of how cascaded control loop architecture helps reduce hunting is provided in paper AT-15-017, "HVAC Nonlinearity Compensation Using Cascaded Control Architectures."

Meghan McNulty, Associate Engineer, Servidyne, LLC, Atlanta, GA: What is the slowest sampling rate tested? Sometimes we only get 30 min on hourly data, so I am interested in how much of the hunting identified in the 15 min interval data from real AHUs could still be detected. Maybe use every other or every fourth data point to test? Very interesting presentation.

Chintala: The slowest sampling rate tested was for data sampled at 15 min intervals. When slower sampling rates are used, the algorithm will be able to identify the undesired oscillations if the duration of hunting is at least four times the sampling rate. So if the sampling rate is 30 min and the duration of hunting is less than 2 h, then the algorithm will not be able to detect the oscillations.

AT-15-030 (RP-1383)

Develop a Radiant System Module for the Simulation and Analysis of Spaces and Systems

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DISCUSSION

Mark Seymour, Director, Future Facilities, London, UK: Have you accounted for the fact that if people move from one condition in the space to another, this will affect the response in terms of comfort?

Charles Barnaby: The current implementation assumes that the occupants are not moving within the space. The software could perhaps be enhanced to evaluate the responses of moving occupants if suitable comfort models are available.