CQI FDS (Field Data Specification) Working Group
Meeting Minutes
Wednesday, September 13, 2017

Call to Order

The meeting was called to order at 11:03 a.m. PDT by Chair Pete Jacobs (BMI). Meeting was scheduled for one hour.

Welcome and Agenda Review

Chair Pete Jacobs (BMI) welcomed members and reviewed the agenda items for the meeting. The focus of the meeting will be spent discussing significant changes made to Agenda Topic #4, Capacity Calculation Procedures (Goal 3). Pete Jacobs (BMI) also set the stage for the next couple meetings which will focus on instrumentation, in terms of equipment selection, measurement techniques, and best practices to minimize uncertainty in the final results.

ITEM	AGENDA TOPICS	DISCUSSION LEADER
3 min	Welcome and Roll Call	PJacobs EGalawish
2 min	Agenda Review	PJacobs
10 min	Status of CQM Data Spec	PJacobs
40 min	Update on CQI Calculation Procedure	PJacobs
5 min	Next Steps for Working Group	PJacobs
	Next Meeting – October 2, 2017 – 11am-12pm PDT	Galawish

Roll Call (*There was not a quorum for approval of the April 6, 2017, meeting minutes*)

Organization	First Name	Last Name	WHPA Category	P=Present
ACCA (Air Conditioning Contractors of America)	Donald	Prather	Contractor Association	P
BMI (BuildingMetrics Inc.)	Pete	Jacobs	Energy Efficiency Program Consultant	P
Daikin Applied	Skip	Ernst	HVAC Manufacturer	P
DNV-GL	David	Cranford	Energy Efficiency Program Consultant	P
NCI (National Comfort Institute)	Ben	Lipscomb	Educator, Trainer	P
NCI (National Comfort Institute)	Rob	Falke	Educator, Trainer	P
SCE (Southern California Edison)	Steve	Clinton	California IOU	P
Staff				
Galawish Consulting Associates (Staff Support)	Elsia	Galawish	Energy Efficiency Program Consultant	P

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Status of CQM Data Spec

Pete Jacobs (BMI) recapped the Working Group's (WG) QM Data Spec activities.

Received four sets of comments – one from an industry member and three from IOU staff. The comments focused on six general areas listed below.

1. Goals and purpose of data spec.
    - *These comments were from people who reviewed it for the first time and were not part of the ongoing Committee. Outside review was critical, so we understand how this document may be received in a wider audience.*
2. Program design considerations.
    - *While an important topic, this is out of scope for Data Spec WG.*
3. Which data elements are required?
    - *Issues around which of the long list of data requirement technicians are required to collect? Are we requiring collection of all data every time a technician goes into the field? Short answer is no. Pete Jacobs (BMI) created a matrix that indicates which data elements apply to various maintenance activities. Not many comments were received on this issue but Pete Jacobs (BMI) noted that the WG can engage with the Maintenance Committee on this subject matter.*
4. Feasibility of making measurements in the field.
    - *How do you really do this in the field?*
5. Suggestions for additional elements.
6. Editorial comments and clarifications.

Going forward, Pete Jacobs (BMI) plans on referring areas 1-3 above to the CQM Committee, incorporate areas 5-6 into the next version of the QM Data Spec, and get that updated version to the Maintenance Committee by early next week. Area 4 will be on the WG agenda for discussions at the next two scheduled meetings.

Update on CQI Calculation Procedure

Pete Jacobs (BMI) – Since December 2017 when the calculations were presented, there have been some important changes and simplifications made. Over the past several months, Ben Lipscomb (NCI) and Pete Jacobs (BMI) have reviewed and simplified the calculations. (See embedded file below for details, Slides 4-20).

Data Spec WG
9-13-17PJ.pptx

Pete Jacobs (BMI) presented an overview of the primary metrics.

- **System Delivered Capacity - both at the equipment level and delivered into the space.** There are two capacity variables: (1) equipment level and (2) system delivered. Once you know the capacity, you can calculate the efficiency based on capacity generated by the unit or system and measured input power. The capacity and the efficiency can then be compared back to the equipment design capacity and efficiency corrected for test condition. For example, if the machine at test condition was designed to put out 60k

BTUs/hr. at the test conditions, and we measure 50k BTUs/hr., we are getting 5/6 of the rated capacity during the test. The idea is to compare the delivered capacity and efficiency to the machine ratings at the test conditions and calculate a score – a fraction of the manufacturer's catalog data. These are the primary metrics, at least on the quality installation side. He noted that most of these calculations are relatively straightforward but the capacity component is especially dependent on instrumentation and measurement accuracy.

- **Equipment Delivered Capacity, Assumptions, and Simplifications** were presented (Slides 7-8). Basically, the relief air and mass flow rate of equipment entering air, both difficult to measure in the field, drop out of the equation. The calculation is thus broken out as both cooling delivered to distribution system and cooling required to condition the outside air.
- **Revised system capacity calculations** were presented and discussed along with the principal measurements: outdoor air supply and supply air flow rate delivered to zone, supply and return air DB and WB measured at zone, and outdoor air and return air DB and WB measured at the unit.

Discussion:

Slide 3: CQM Data Spec Status

- In response to Rob Falke's (NCI) query about Slide 3, the overall take on the CQM data specs from reviewers' perspective, Pete Jacobs (BMI) noted reviewers were generally positive. Some really good feedback was received on things we did not think about including—suggestions to add some additional elements. Some reviewers did not realize that the calculations are limited to single-zone systems. We will clarify this is the final document.

Slide 5: Primary Metrics

- Pete Jacobs (BMI) clarified that both the system-delivered capacity and the equipment-delivered capacity will be measured.

Slide 9: In order to conduct the capacity calculation, principal measurements are outside air entering and supply air flow rate, supply, outside air, and return dry bulb and wet bulb temperatures.

Don Prather (ACCA) – This makes sense except that you will only know how that piece of equipment is operating at that moment not what the capacity is.

Pete Jacobs (BMI) – This provides the cooling capacity that piece of equipment is generating at the test conditions. Next step is to compare to what the equipment should be delivering under the same conditions by looking at the manufacturer data—outdoor dry and entering wet bulb of the test conditions.

Don Prather (ACCA) – In a similar situation, stickers with manufacturers' data were placed on the equipment so the technicians will have it readily available.

Skip Ernst (Daikin Applied) – Will the WG discuss the measurement accuracy, particularly mass flow?

Pete Jacobs (BMl) – As noted earlier, the WG will use the next two meetings to have in-depth discussions on measurement accuracy and best practices. I have provided some pro forma opinions on measurement accuracy collected within ASHRAE 221 Committee.

Slides 12-13: Simplifying Assumptions

- Pete Jacobs (BMI) / Ben Lipscomb (NCI) – Found a way to eliminate the variable—average enthalpy of "makeup air" for imbalances—to improve the calculation. This variable had too many assumptions that were very specific to certain buildings' conditions and thus was problematic.

Slides 14-19: Revised System Capacity Calculations – Equations Review

Slide 16—Rob Falke (NCI) – One problem we had and the reason we use equation 4 to calculate the outdoor air load (energy balance on mixing box) is that field measurement of mixed air enthalpy, especially in commercial package units, is very difficult. The proximity to the coil – depending on where the air is mixed etc. – makes field measurement consistency difficult.

Skip Ernst (Daikin Applied) – Fan heat will give some difficulty in the calculation, and any leakage at any point may influence outdoor air load (e.g., cabinet leakage, air going around the fan, bypassing coil and ambient conditions)-this will at any point influence this calculation. Not sure if this is significant but this can present difficulty when conducting the comparisons if not careful. Net outside the system is of interest but be careful you are not comparing a 'net' and a 'gross.'

Pete Jacobs (BMI) – Clarified that Coil Load is coil load net of fan heat.

Don Prather (ACCA) – It is important to look at data because some include fan heat and some do not. Any bypasses would affect the supply conditions (exiting conditions). Cabinet leakage is not included.

Pete Jacobs (BMI) – Will need to look into this.

Rob Falke (NCI) – When this process started, the industry mostly thought of laboratory equipment ratings and those standards. This standard calculation is measuring deterioration of installation on the system – what is really occurring in the field. Many of these defects are in the system and the measurements account for this. There are many defects we pick up—coil bypass, excess fan heat beyond rating assumptions—and although we will not have a perfect comparison, it will be a reality of what is occurring in the field compared to how the manufacturers rate the equipment under those conditions. The calculation is subject to uncertainty in field measurement but it also documents the reality of how the equipment gets installed. Had to make some assumptions for consistent accuracy.

Slide 19—Pete Jacobs (BMI) – Bottom line—Equation 12 is what we came up with. It looks similar to the equipment calculation except that we are looking at zone level supply air flow and zone level return and supply air enthalpy differences as opposed to equipment level. The principal measurements now are:

- Supply air flow rate delivered to zone,
- Supply and return air dry bulb and wet bulb measured at the zone, and
- Outdoor air flow rate, outdoor air and return air dry bulb and wet bulb measured at the unit.

These measurements are a lot simpler. One measurement was eliminated—the need to measure zone level airflow both on the supply and return side. We are summing supply air delivered to the zone through the supply registers. There are essentially two air flow measurements: (1) outside and supply air and (2) a series of dry bulb and wet bulb temperatures both inside the zone and at the system to calculate the delivered capacity.

Rob Falke (NCI) – After comparing the method of field measurement to the proposed new method, measurement time was reduced by ⅓ and it appears to be fairly consistent with previous results, within a few percentage points.

Don Prather (ACCA) – When conducting the field comparison, were these in applications where ducts are all in the air-conditioned space, the unconditioned attic, or on the roof? On what types of buildings does this method work best?

Rob Falke (NCI) – The comparison was done on residential and commercial buildings. I asked the technicians to keep track and use both testing methodologies, document the difference, the time saved, and if accuracy was there on different types of systems.

Pete Jacobs (BMI) – Infiltration on the return side does affect the calculation. This is accounted for in the equation.

Next Steps for Working Group

Pete Jacobs (BMI) – We have identified a set of measurements that it takes to quantify capacity and efficiency. The next steps are to discuss the following during the next two WG meetings:

- Best practices for making measurements: A*irflow at the unit and in the space, dry/wet bulb measurements, quasi-steady state nature of test procedures and how to deal with this, and instrumentation via communicating sensors which allow multiple simultaneous measurements. We also want to discuss some comments received on the maintenance side about how to get good static measurements, especially if doing a static pressure profile on a unit. What are the "tricks of the trade"?*
  - *Instrumentation*
  - *Measurement techniques*
- Assess measurement uncertainty: *How good measurements are in terms of uncertainty band around these quantities.*
- Calculate uncertainty in key performance metrics: *After determining the uncertainty, propagate these through the system calculations again using the error propagation technique.*

Slide 22—Pete Jacobs (BMI) **–** Pro Forma Uncertainty Specification and Assumptions (from ASHRAE 221 Committee). Pete Jacobs (BMI) wants everyone to review the values and use this as a starting point on what we think we can get from an uncertainty perspective, given good instrumentation and best practices in terms of making measurements.

Rob Falke (NCI) – Volunteered to solicit instrumentation industry experts from the ASHRAE 221 Committee to present at one of the next two meetings.

Action Items, Next Meetings, Adjourn

Action Items

- Pete Jacobs (BMI) to incorporate final comments into QM data specs and distribute updated version to the CQM Committee by early next week.
- Pete Jacobs (BMI) to send updated version of presentation to WG for review and comments.
- Rob Falke (NCI) to solicit an industry expert to present on 'instrumentation' at one of the next two meetings.

Next Meetings

- Monday, October 2, 2017; 11:00 a.m. – 12:00 p.m. PDT
- Monday, October 23, 2017; 11:00 a.m. – 12:00 p.m. PDT

Adjourn

The meeting adjourned at 12:00 p.m. PDT.

Submitted by Elsia Galawish, WHPA Staff
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