Goal 2: Commercial Quality Installation SFDS Working Group
Wednesday December 4, 2015 Meeting Notes

Call to Order

The meeting was called to order at 9:05 am PST by Pete Jacobs, BuildingMetrics Inc. and Chair. Meetings are normally scheduled for up to 2 hours.

Roll Call

Quorum for voting organizations = 13 of 24. 8 of 23 voting members, 4 non-voting members and 1 guest/staff attended this meeting. A total of 13 members and guests were in attendance.

P = present at meeting
A = absent voting member; if proxy has been assigned it will be noted below.

WHPA Goal 2: CQI SFDS Working Group VOTING Members				Roll Call
ACCA (Air Conditioning Contractors of America)	Donald	Prather	Contractor Association	P
Aire Rite AC & Refrigeration	Larry	Smith	Contractor (Nonresidential)	P
BMI (BuildingMetrics Inc.)	Pete	Jacobs	Energy Efficiency Program Consultant	P
Carrier Corporation	Dick	Lord	HVAC Manufacturer	
CDH (CDH Energy Corporation)	Hugh	Henderson	Energy Efficiency Organization	
Clean Energy Horizons, LLC	Norm	Stone	Energy Efficiency Program Consultant	
Cooper Oates AC	Gary	Storck	Contractor (Nonresidential)	
Daiken Applied	Skip	Ernst	HVAC Manufacturer	P
DEG (Davis Energy Group)	Dave	Springer	Energy Efficiency Organization	
DNV-GL (formerly KEMA)	Jarred	Metoyer	Energy Efficiency Program Consultant	
Energy Analysis Technologies	Chris	Ganimian	Consultant	P
Energy Solutions	Jim	Hannah	NR	
FDSI (Field Diagnostic Services Inc.)	Dale	Rossi	Third Party Quality Assurance Providers	P
Galawish Consulting & Associates	Elsia	Galawish	Energy Efficiency Program Consultant	
HSGS (Honeywell Smart Grid Solutions)	Shayne	Holderby	Energy Efficiency Program Consultant	
IC Refrigeration	Richard	Imfeld	Contractor (Nonresidential)	P
JCI (York Unitary)	Bryan	Rocky	HVAC Manufacturer	
Marina Mechanical	Denny	Mann	Contractor (Nonresidential)	
NCI (National Comfort Institute)	Ben	Lipscomb	Educator, Trainer	
PG&E (Pacific Gas and Electric)	Adam	Scheer	California IOU	
SCE (Southern California Edison)	Steve	Clinton	California IOU	P
University of Nebraska (Lincoln)	David	Yuill	Educator, Trainer	
XCSpec	Jan	Peterson	Controls (Manufacturer or Distributor)	

WHPA Goal 2: CQI SFDS Working Group Non-VOTING Members				Roll Call
ACCA (Air Conditioning Contractors of America)	Wes	Davis	Contractor Association	P
ACCA (Air Conditioning Contractors of America)	Glenn	Hourahan	Contractor Association	P
Aire Rite AC & Refrigeration	Don	Langston	Contractor (Nonresidential)	
NCI (National Comfort Institute)	Rob	Falke	Educator, Trainer	P
SCE (Southern California Edison)	Lori	Atwater	California IOU	
PG&E (Pacific Gas and Electric)	Robert	Davis	California IOU	
SCE (Southern California Edison)	Steve	Clinton	California IOU	
SCE (Southern California Edison)	Andres	Fergadiotti	California IOU	

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SCE (Southern California Edison)	Sean	Gouw	California IOU	
XCSpec	Jeff	Aalfs	Controls (Manufacturer or Distributor)	P
WHPA Goal 2: CQI Committee Invited Guests and Staff				Roll Call
STAFF				
BBI (Better Buildings Inc.)	Dale	Gustavson	WHPA Executive Advisor	
BNB Consulting/WHPA Staff, host, admin. support & scribe	Bob	Sundberg	WHPA Staff	P
Enpowered LLC	Shea	Dibble	WHPA Co-Director	
John Hill **	John	Hill +	(CPUC/ED Ex Ante Consultant)	

** *Organization is Not a Member of the WHPA; + Individual is NOT Registered with the WHPA;*
(P) after last name = *Member/Registrant is Pending Approval from the WHPA Executive Committee*

AGENDA

Topic	Discussion Leader	Desired Outcome
Welcome, roll call, approve past meeting minutes, review ACTION items and agenda	Pete Jacobs and Bob Sundberg	Record meeting attendees, finalize past meeting minutes, review status of meeting action items.
Welcome new members & guests	Pete Jacobs	New members and invited guests welcomed.
Identify performance indicators for diagnostic testing	Pete Jacobs	Provide members with CQI C. background, where the WG goal fits into the overall CQI C. goals
Unit (machine) performance	Pete Jacobs	Agreement on "what" measurement data needs to be collected in order to allow unit/system performance to later be determined.
System delivered performance	Pete Jacobs	Agreement on "how" measurement data needs to be collected in a standardized, repeatable and affordable manner.
Discuss revisions to Standardized Field Measurement Data Specification	Pete Jacobs	Decide what tools and instruments are necessary and highly recommended for accurate field measurements.
Summarize meeting, assignments/ACTION items, set next meeting date/time, adjourn	Pete Jacobs and Bob Sundberg	Set next meeting date, confirm time, review any new ACTION items and next meeting agenda items.

Approve Minutes of Previous Meeting

The November 13 meeting draft notes were distributed November 24. No suggested revisions were received. Meeting notes were approved as distributed. Final minutes would be posted to the working group's location within the WHPA/CQI Committee website.

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Review Status of Action Items from Previous Meeting

November 13 ACTION: Jeff Aalfs, XCSpec, would introduce Chris Ganimian to the FDD Committee and Chris's interest to have that committee focus on standardized FDD protocols and use of FDD technologies in utility programs. Completed.

November 13 ACTION: Dick Lord, Carrier, offered to provide the group with a copy of the white paper he'd authored related to test parameters and procedures. Pending.

November 13 ACTION: Dale Rossi directed Bob Sundberg to send a draft of the CQM Standard 180 Maintenance Task Working Group's Economizer System Table 5-12 report to all members of the CQI SFDS Working Group. Completed.

Welcome New Members and Guests

None.

New Business - Pete Jacobs

None

CQI Standardized Field Measurement Data Specification WG (CQI SFMDS WG) - Pete Jacobs

Pete Jacobs, BuildingMetrics Inc. (BMI) and Chair, had prepared a short PowerPoint presentation to help guide the group through comments received and their review of the data specification draft.

Slide 2 Major Takeaways from Meeting #2

- Defining trigger points (need for performance evaluation) for measurement activities
- Define data collection needs at each trigger point
- Takeaways from Meeting #2

Pete didn't get any specific comments back after sending out the revised spec. He did get quite a few general ones. When was it appropriate or necessary to collect this data. And, for each type of situation, what data needed to be collected. He'd planned for that to be the main topic for this meeting. He'd revised the spec. spreadsheet and organized it around three triggering situations based on feedback at and after the last meeting.

One big takeaway from the last meeting involved understanding the issues involved in one time field measurements where you couldn't control conditions like in a lab. During the test period conditions might be only in a quasi-steady state. That had to be recognized. The challenge was how to deal with those measurements.

Slide 3 Trigger Points

- Not every activity required a full set of data collection
- Need to define trigger points in terms of the activity and frequency
- Need to identify what data to collect for each trigger point (activity)

Slide 4 Starter list of Trigger Points - Activities

- Benchmarking or Commissioning (Cx - most complete and rigorous collection)
- Maintenance (benchmarking activity, less rigorous at some point)
- Repair

- System Renovation
- Measure Installation (utility program incentivized system upgrades)
- Other?

Dale Rossi, FDSI, asked what range of equipment this specification was intended for.

Pete Jacobs responded that he thought they should limit their work to residential and light commercial packaged equipment.

Slide 5 - Trigger Points

- Initial benchmarking or Cx
  - General Job Data
  - General System Information
  - Full performance data
- Maintenance
  - Track what was done and data related to activity
- Repair
  - Track what was done and data related to activity
- Measure installation
  - Measure specific data collection requirements
- Renovation
  - Full performance data
- Periodic benchmarking
  - Full performance data

Rob Falke, NCI, shared work his firm had been conducting supporting a SCE commercial installation program using their firm software. The full suite of benchmarking data collection was being done for those installations. They'd also been collecting before/after data at Standard 180 program sites before any work was done and then afterward to show the delta or change in performance. In some cases, even after pre-maintenance data was collected, customers chose to not do some of the recommended work. About a third of the systems where data had been collected was outside utility programs to see what was happening and to be able to educate the customer. There was abbreviated testing during maintenance and a higher level of tested during service and repair. It was also being used in new construction as part of the commissioning. There is a lot of data that needed to be collected for all those different situations. And, this software takes data points from existing standards from across the industry that had been developed over decades. He thought this effort was to take all those existing standards and bring them together to support an effort to assess performance that the industry was moving towards.

Pete Jacobs stated that maintenance spanned an array of activities from quarterly maintenance to semi-annual cooling and heating startups. He asked the group about measurements that would be taken within maintenance. Whether it was equipment that was being taken into a utility program? Data collected once a unit was brought up to some reasonable level of operation? How did that play out?

Dale Rossi, FDSI, commented regarding commercial packaged units, mostly at multi-site customer circumstances. Maintenance was a continuous process. It was a process to maintain or incrementally improve its operation. Quarterly maintenance referred to a more cursory mid-season service, often termed filter changes and inspection. It was mostly observations like for UV lamps and generally didn't involve collecting measurements or data. The spring start-up had a much heavier concentration on the refrigeration cycle evaluation. The fall start-up would

concentrate on whatever the heat generating appliance was. Maintenance on the economizer system could either be annual or semi-annual inspections. He was confused because refrigeration cycle activities were listed on the in-field test data tab under Commercial Maintenance Diagnostics but not listed under Commercial Maintenance Performance Benchmarks. He wasn't sure what the titles for those columns referred to so it was hard for him to analyze what was included or omitted.

Pete Jacobs asked Dale Rossi whether it was appropriate to take data during those seasonal start-up activities?

Dale Rossi responded that if you went by either what he termed commercially reasonable maintenance or Standard 180 guidelines, taking performance data would be something you did once a year. All of the refrigeration cycle temperature and pressure data would be required to be taken once a year in the spring. Heating performance data would be required to be taken in the fall.

Dale asked Pete what the titles of those two columns meant - Commercial Maintenance Performance Benchmarks and Commercial Maintenance Diagnostics? Was the benchmark intended to mean the first time you visited the unit when you were trying to benchmark everything? Pete agreed. Dale then asked why wouldn't you take the refrigeration temperature and pressure readings to collect that data during the benchmarking process?

Pete Jacobs responded that you probably should take those measurements during a benchmarking process. This table was a draft and would need to be revised.

ACTION: Pete Jacobs would revise the draft spec. to include refrigeration measurements being taken during commercial maintenance performance benchmarking.

Dale Rossi also commented that there was a lot of emphasis on airflow measurements being taken in this set of tables. But, maintenance did not have a history or practice of taking airflow measurements during a commercial maintenance inspection. Technicians were not generally trained or equipped for that. There wasn't enough time for that. No one could sell the need to their customers. Customer decision-makers were of the opinion that the cost for taking those measurements was high and the benefits were low.

Rob Falke commented on how he and Dale Rossi represented the two different perspectives. Airflow measurements were left out in the delivered maintenance world that Dale worked in. In the world that the airheads lived in, you couldn't do service without some of that benchmarking measurement being taken. The refrigeration circuit was looked at by those guys from airside performance. He believed you could isolate and look at refrigeration performance from the air side. If needed, if there was a problem indicated from the airside, they'd then proceed with refrigeration diagnostics. On the commissioning side, he thought that they didn't dip into refrigeration diagnostics unless there was some indication of a need. They were just different perspectives on how you approached a system. He thought the specification needed to provide for both perspectives. The purpose for this WG was to take all of the perspectives and all of the standards, put them together and move ahead of where we are now.

Dale Rossi agreed with Rob that there were these two perspectives. The table that was being reviewed represented the airside very well. His purpose on the WG was to represent the refrigeration side perspective.

Pete Jacobs agreed with both and said that, depending on the activity, they could certainly benchmark refrigeration performance without having to take airside measurements. They could also benchmark performance with airside measurements as well. It depended on the nature of the activity. If the technicians were hooking onto the unit for seasonal evaluation then they could record measurements from the refrigerant side. If they were not hooking onto

the system (refrigerant diagnostics), it would then be possible to record measurements for benchmarking performance from the air side. There were probably instances where that made sense, especially with new equipment or where there was no overt indication of refrigeration issues. There would be instances where one was appropriate and instances where the other was. When you needed to examine distribution efficiency you clearly were moving strictly into the realm of airside measurements. Their intention was to be inclusive and include both types of measurements wherever appropriate.

Dale Rossi added that commercial maintenance was a really mature industry with established ways of doing things. Airside measurements were not currently considered part of quarterly or annual commercial maintenance. Those measurements would be considered more of a retro-commissioning thing. To the extent that you tried to represent airside measurements into the quarterly environment, you're swimming upstream. It's not part of that tradition.

Pete Jacobs agreed with Dale's statement. His perspective was that at the quarterly, mid-season maintenance, it was appropriate to be more of an activity tracking. Not so much a quantitative data collection. Just checking off what was taken care of at the quarterly interval.

Jeff Aalfs, XCSpec, stated that he'd recently met with Larry Smith and also with Jeff Sturgeon and Mel Johnson of NCI. They'd shared a lot of airside measurement data taken mostly by Christina Rodriquez. He asked how often those were being taken. He knew it was pretty time-consuming and wondered about the frequency of taking airside measurements. Would it be an annual thing?

Larry Smith, Aire Rite AC & Refrigeration answered that those measurements were normally taken when they'd noticed an issue with the building HVAC system or when there was a customer complaint. They were at a restaurant where there are often air balance issues. They'd usually respond to hot or cold complaints or high utility bills. It used to be that they'd just look at the refrigeration side. He'd learned that the air side could have an equal or even bigger impact on comfort than the refrigeration side. The approach you took really depended on the situation. Responding to a customer complain, a new install or whatever. The situation dictated where you'd start.

Pete Jacobs asked whether he'd call that example responding to a repair or service call trigger point. Not a scheduled maintenance call.

Larry agreed but added it could also be from the technician noticing an indication of an air balance issue. When entering if they were sucked in or blown out. As they'd increased technician training, they were noticing more of these airside issues. As Dale indicated, techs traditionally were more focused on the refrigeration side. It had been quite a challenge to get techs more open to change. Larry didn't think that it needed to routinely be done yearly. Maybe every other year would be more realistic. Or any time a piece of equipment was changed out or motors and pulleys were replaced. Air balance might need to be readjusted. He added that air balance was more critical in a restaurant than in an office building or other building types.

Rich Imfeld, IC Refrigeration, agreed that airside measurements could be taken responding to hot/cold complaints. But, he agreed with other statements made that trying to routinely take all those airside measurements took time. Who would pay for that extra time with maintenance being viewed by so many customers as a commodity.

Larry Smith stated that correcting air balance issues with restaurant customers was starting to change since they were able to often show huge changes in their utility bills afterward. They were becoming a lot more accepting of airside diagnostics. Especially when something was noticed during a maintenance call. The issue became a triggering event. That represented about 30% of the time. The majority of times it was driven by a customer complaint of some kind. Temperature, balance, some other issue the customer noted that created a service call.

Pete Jacobs summarized that this sounded to him like the maintenance activity might notice an airside issue. But, the evaluation or correction would come under a repair or service activity which would trigger a more complete data collection. An issue might be noticed during a maintenance call but you wouldn't address it or correct it until you'd made a proposal to the customer that was approved to move ahead. It would be turned into a repair or service request for which they'd pay extra.

Rob Falke, NCI, added that they were looking to have this group go beyond the typical air balance assessment and report. This data to be collected would be intended to be used to provide an assessment of unit/system performance that would be taken up by the next working group. The average performance his firm had documented from commercial building initial assessments was about 50%. Only delivering about 50% of what the equipment was rated at in the laboratory. This meant that the actual system performance was far below what the industry assumed it to be. If that was true there was a huge opportunity both for contractors and their customers. He hoped that data collected as part of a California utility program would be released soon. In contrast, residential performance was found to be about 57% on average. When replacing those residential systems with higher efficiency equipment under a residential QI program, without addressing any delivery system issues, that improved to about 63% of rated equipment performance. When distribution system issues were address, refrigeration system diagnostics were employed and all industry standards were considered, the average system was seen to improve into the upper 80% range. The goal of this quantification of field performance, even with all the weaknesses of any one single approach as Dale and he had often discussed, there was a huge opportunity. That holistic approach was the purpose behind trying to develop this specification.

Dale Rossi stated that he hadn't realized that that goal was the reason for developing this specification. If that really was the objective, he was fully supportive of identifying what would provide those hints while conducting maintenance, what clues would trigger the need for a more extensive airflow investigation. The work of his CQM Maintenance Task Working Group earlier had determined that total external static pressure measurements would reasonably be added to a maintenance inspection. Once the holes were drilled and sensor locations identified, technicians were already capable of taking and recording those measurements. Something like that that would take less than five minutes and give an indication was actually achievable. This airside approach was laudable. But, you needed to determine what could be done under the different set of "maintenance" circumstances and time constraints. If you could have these small extra efforts, tweak maintenance tasks a little and be included in a maintenance budget, it would be more successful.

Pete Jacobs tried to restate Dale's point. So, there was a need to define a maintenance and inspection task which would include some airside distribution measurements which could trigger further investigation when needed.

Dale Rossi responded that what was needed was either a maintenance task or set of measurements and data that when analyzed would provide a pass/fail answer. Rob was right. If you had this approach you'd find lots and lots of equipment out there that would fail.

DECISION: Agreement that defining maintenance tasks and/or airside measurements that when analyzed could provide a pass/fail indication for performance would be an asset to providing a cost-effective trigger for further appropriate system investigation.

Rob Falke brought up one of the suggestions made by Dale's maintenance task working group about affixing a label to units or a digital record with only six or eight points to check on maintenance inspections that wouldn't take very long to do against some earlier established benchmark measurements. If airflow changes, the coils got dirty, filters were loaded up or duct system damage. You could see all of that on a static pressure profile that

would take less than five minutes. Then, to determine from these inspections whether there was any major change since the last inspection, he thought that was how this was tied into maintenance.

Larry Smith added that his firm had completed thirty to forty thorough evaluations and data collections both before and after Standard 180 maintenance was completed. That included incorporating both airside and refrigeration side measurements in an effort to validate the huge impact of those maintenance activities.

Rob Falke offered to work with Larry Smith to identify those jobs in order to access and share the data from those evaluations to show details of what was measured and what the results were.

ACTION: Rob Falke and Larry Smith would work together over the next couple of weeks to identify recent jobs where full before/after evaluation data was collection for Standard 180 program customer units. Rob offered to pull the data and share the data and analysis with this group to demonstrate the impact of Standard 180 based maintenance and their approach to data collection and analysis.

Pete Jacobs returned to Slide 6 and noted that, as Dale had pointed out, a maintenance activity included what was contracted and could throw up flags about potential faults which required further investigation and often repairs. Maintenance inspections were intended to provide fairly routine, low cost interventions only. But, techs would have their eyes and ears open to noticing conditions that could trigger repair or renovation proposals and work beyond contracted maintenance costs.

Dale Rossi commented on how his perspective on maintenance differed from his employees. Techs considered maintenance as contracted work they had to suffer through and get done as quickly as possible. It took a long time for many techs to be convinced that they were being paid to conduct a sales call, to look for opportunities to look for service work that allowed Dale to write their paycheck. Maintenance was not a necessary evil. It was an opportunity. That concept was foreign to most techs who'd worked for him.

Rob Falke commented that a new trend in maintenance was to add the ductwork to the rest of the HVAC system. This allowed them to add and take static pressure and temperature measurements and differentiate themselves from other contractors as well as find indications of fault further down in the system.

Pete Jacobs summarized that he'd heard that refrigeration measurements were only taken once a year and that airside measurements taken every other year or as complaints of observations might trigger a look for ongoing benchmarking.

Dale Rossi corrected Pete in that the airside measurements over couple of years was more aspirational that real. They were rarely done though they ought to be.

Pete Jacobs and Rob Falke agreed that the activities were sequential. First would come a new installation or retro-commissioning of a system. This was followed by maintenance which attempted to maintain that level of operation. At the maintenance level, data collection needed to be less onerous.

<u>Slide 6 - Examples of data collection</u>

- Filter change
  - Date of change out
  - Other?
- Coil cleaning
  - Date of cleaning

- Cleaning method based on condition and type of coil (fin/tube and micro-channel)
- Other?

- Charge adjustment
  - Date
  - Test in temperatures and pressures
  - Test out temperatures and pressures
  - Other?
  -

Dale Rossi added maintenance tasks related to UV lamp inspections and being sensitive to biological growth in the system, primarily visual checks. Condensate check and removal and economizer system & those filters as well needed to be added. Regarding coil cleaning, Dale didn't endorse the common practice of coil cleaning based on a calendar schedule. Coils should only be cleaned when there was evidence of substantially lower heat transfer otherwise it was a total waste of maintenance resources, cost and impact on the life of the coil. A coil might need to be cleaned every couple of months or only once a decade depending on many factors. From his past experience, only about 1/3 of the rooftop unit coils needed cleaning at any one time depending on conditions.

Bob Sundberg, WHPA staff, asked Dale about what methods might be used to determine when coils needed to be cleaned.

Dale Rossi answered that the required measurements were already in the spec. table. The challenge was what a tech could do with those readings. The 2015 SCE commercial maintenance program had just established a $50 incentive for contractors use of refrigeration fault detection and diagnostic technologies during new unit benchmarking and bringing units to acceptable (baseline) program operation. The HVAC Service Assistant was the first approved FDD technology though program staff was seeking others. The CQM Maintenance Task Working Group had develop substantial effort working on this issue of how do you know how a specific unit should be running under its current conditions. The Service Assistant has a "no fault" model. If you put in the equipment profile information and driving conditions, it will tell you exactly how the machine ought to be running under those conditions so you can adjust to that. Regarding coil cleaning, generally speaking you are look at the condenser over ambient (COA) temperature. When it got over a certain threshold, it should be cleaned. You could create a rule of thumb, say COA > 25 to 30 degrees F which would justify a coil cleaning. If it isn't that high, coil cleaning wasn't going to solve anything in the condenser. In contrast, there would be a variety of reasons why the evaporator wouldn't be absorbing heat correctly. Factors could include airflow, a dirty coil, the metering device or charge level. All of these would have to be considered.

Rob Falke said the airside approach would look for a pressure drop from a benchmark reading across the evaporator coil. That's how he'd look at evaporator coil cleanliness.

Dale Rossi responded that Rob's assessment works for residential applications and it ought to work for commercial but didn't. It didn't work because there was rarely a recorded benchmark at commercial sites. Every time a tech visited it was sort of like a visit for the very first time. Most were never commissioned properly to begin with and no records were kept since installation. His working group came up with the idea of this equipment sticker, as Rob had indicated, that would stay with the unit no matter which firm provided maintenance services.

Pete Jacobs suggested they add condenser over ambient (COA) readings on the condenser side.

Dale said he had a specification written out which defined when coil cleaning needed to be done. He offered to send it out to Pete and the group.

ACTION: Dale Rossi volunteered to send out his specification which defined evaluating condenser coils and provided guidelines for under what conditions he'd determined that a coil needed to be cleaned.

Pete Jacobs continued by leading the group through information relevant to charge adjustment. He asked whether it was reasonable to collect electrical power measurements whenever a charge adjustment was determined necessary.

Rob Falke expressed concern over how many different readings would be expected to be taken in this specification. The MPS requirements within the SCE maintenance program required hundreds be taken. He wondered whether this specification could point to this like to other standards elsewhere to refer folks using it to the source?

Pete Jacobs answered that one way would be to step through Standard 180 and determine which measurements referenced in the standard were appropriate and included in this specification.

Bob Sundberg, WHPA staff, cautioned the group that you couldn't just go to the most recent 2012 published version of Standard 180. Critical measurements were not well spelled out in the Rooftop Unit Table 5-22. That was part of the work Dale Rossi's working group had devoted so much time to develop recommendations for to the Standard 180 Committee. That committee was just being re-convened and hadn't yet reviewed and decided on what suggested revisions to adopt. In that rooftop unit table under task "n" it only stated to check refrigeration temperatures. It didn't detail which pressures and temperatures needed to be examined or how it could be done properly or what to do with those findings.

Dale Rossi agreed that the Standard 180 maintenance table tasks were very generic statements. They were better described as activities, not specific, detailed maintenance tasks. In his opinion, the meat of Standard 180 was Section 4 on development and implementation of a maintenance program and the process of fostering communication between the service provider, their staff and the customer. Determining condition indicators, performance objectives (goals). Communication and periodic reporting which needed to be well defined. What goals were agreed to, whether they were being met, if so how documented, if not - why not? Were they unreasonable, under resourced to accomplish. The standard was not primarily the equipment maintenance tables which most people assumed and skipped to. Dale believed those tables should have been informative appendices. The tables were really a red herring.

Dale had previously recommended work be supported for developing a reporting standard. You'd only want to collect data to report something, perform calculations, for instance, which would substantiate a level of operation. That's why he'd suggested earlier that you first needed to determine what you wanted to achieve. Then, determine what data was needed to assess or evaluate whether that goal was achieved or do the calculations you'd determined were critical to assess. Whether the needed data was reasonable to expect being collected in the field from technicians. Knowing where you want to end up was very important to determine up front.

Circling back to Pete's original question about collecting electrical data whenever charge adjustment was being done, Dale said it was fairly quick to determine and reasonable to ask a technician to do. Voltage and current were fairly simple but power factor was not. You'd probably have to estimate power factor. He questioned was why you'd want it? What would you do with that data? The Service Assistant used compressor mapping. For each tonnage and every set of suction pressures and temperatures, it would calculate a per ton kW usage within +/- 2% so he'd not seen the need to have techs manually take those measurements.

Rob Falke offered that one of the goals and calculations he could see these measurements being used for was to calculate a field determine EER. There was a lot of doubt being expressed about whether that could be determined since they were not in a laboratory with its steady state conditions and instrumentation. But, that seemed to be a golden number from which energy savings could be calculated. With EER = BTUs/Watts. Watts was the power factor corrected true RMS watts. He believed there were very affordable instruments that his firm had used with good success. The other measurements could help determine a system delivered BTU metric. With those two readings, he thought you could begin to look at field performance, performance in a very new way.

Bob Sundberg, WHPA staff, asked Rob what measurements would need to be taken and where to determine system delivered BTUs.

Rob Falke answered that all the necessary measurements were already included in the tab under In-Field Testing. The tricky part was taking those measurements when the system was under a full load. Being that when on, the system was constantly changing things, that was one of the challenges of field measurements only being in a quasi-steady state. Another tricky aspect was being sure to grab equipment and system measurements at the same time. BTU = airflow X temperature change (wet bulb or dry bulb) X BTU factor X correction factor. With good software you could easily calculate BTUs. If you conducted a "test-in" and "test-out" under different conditions you could always go back and correct back to the manufacturer's test conditions.

Dale Rossi offered that from the refrigeration side, BTUs = change in enthalpy X mass flow rate of the refrigerant. You'd need to take the pressure and temperature readings on both the liquid and suction lines. Get your enthalpies and find the corresponding change. For those readings, go back to the compressor mapping where for every combination of head & suction pressures you'd determine the mass flow rate +/- 7 to 8%. The mass flow rate X change in enthalpy = BTUs. The compressor map was a table provided by every manufacturer. For every combination of liquid and suction line pressures it would list the mass flow rate and kW power requirement in each table cell.

Rob Falke thought it was important to replace the current assumptions and SWAGs with calculations of field performance from field measurements. Tools to collect the measurements and complete the calculations was really a necessity.

Dale Rossi stated he was in complete agreement with the goal. But, if you replaced assumptions with field measurements, you ended up with calculations that required the type of knowledge and capability that was not common in current field technicians. It's become complex enough to not be doable without a technology assist.

Jeff Aalfs, XCSpec, commented that their monitoring units were able to collect current but not voltage or power factor information. They also couldn't currently get measured/calculated airflow. All necessary for even a crude field EER calculation. With assumed values for several of those missing factors, they could produce a benchmark EER reading from which future determinations could be compared. No very exact but it would provide a clear indicator of any major issue that was developing.

Dale Rossi added that the HVAC Service Assistant could provide a field calculated efficiency compared to the unit's rated efficiency +/- 7%. He reminded the group that this was a refrigeration/unit tool, not an indication of system delivered efficiency. Questions about what happened after the rooftop unit were important and interesting questions. But, the Service Assistant couldn't provide any indication beyond unit efficiency.

Dale wanted to also discuss the 15 minute interval data that was accessible from the new building smart meters. They were graphing the building power usage against the outdoor wet bulb temperature. It was usually flat until

it reached a certain outdoor temperature which they understood to be the base building load. Once it increased he understood that to be the additional HVAC cooling load. You could analyze those trends to determine temperature dependent energy use in a building before and after an event.

Pete Jacobs thought that was a very interesting topic but probably beyond the scope of this working group.

Slide 7 - Examples of data collection

- Economizer Maintenance
  - Min OA position
  - Changeover setpoint
  - Functional test type
  - Functional test result
  - Other?
- Economizer Repair
  - Track repairs made
  - Functional test type
  - Functional test result
  - Other?

Pete solicited comments regarding economizer maintenance measurements

Rob Falke offered that the damper position didn't provide any meaningful information unless you also had live airflow measurements to go along with it. It could be closed and still be allowing 20% outside air (OA). He thought that economizer min/max airflow could easily be measured in the field. That connection had to back into the spec.

Dale Rossi wanted to comment on maintenance and the appropriate amount of data collection when delivering maintenance. He didn't think there was any industry consensus to the questions they'd been raising. He quoted Rob saying it was easy to measure airflow going through an economizer. In the CQM MTWG discussions it had never been considered an easy thing to do. In commercial maintenance the current standard meant that you had to complete a task in about 5 minutes and repeat that 100 times a day (8.3 hours). What his working group came up with was the realization that the new digital economizers kept track of economizer operation and reported out if/when faults occurred. They'd also concluded that you couldn't know how an analog economizer was operating without extensive data logging. That was very rarely done.

Rob Falke asked Larry Smith how long it took to measure airflow through the economizer. Larry replied, just a couple of minutes if the holes for the instrument were already there. Maybe a five to seven minute process at most.

Dale Rossi asked if this was a total static pressure measurement taken after the economizer but before the evaporator coil? Larry responded, no, that it was an actual flow measurement. You could use a hot wire anemometer that delivered actual CFM, rotating vane probe or bell grid if there wasn't too much wind. You just plugged in the dimensions and the newer instruments would calculate the CFM airflow.

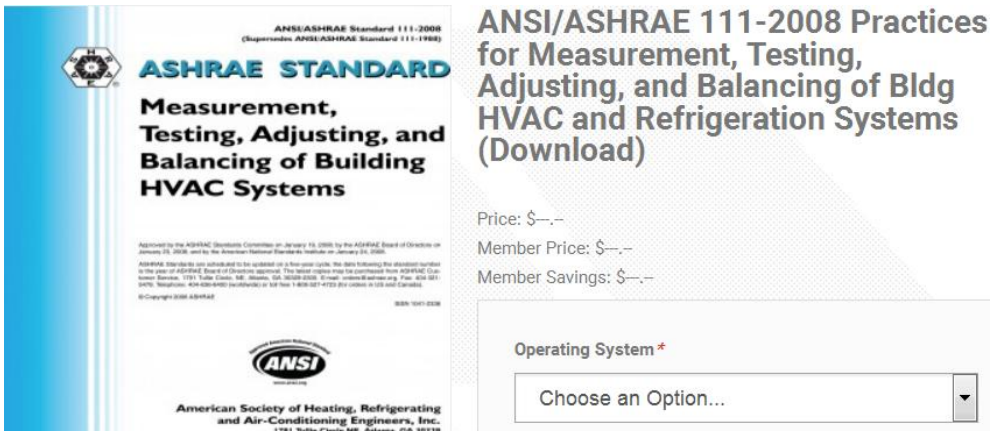
Dale Rossi asked whether all the Aire Rite techs were outfitted with hot wire anemometers? Larry responded that they didn't all currently. But, that all the techs working on CQM program accounts did and those 30 or so out of the 25 techs who worked on maintenance beyond the CQM standards. Dale just wanted to make the point that it wasn't common for maintenance techs to have and use those airflow instruments. It currently required someone like Don Langston to outfit his crew with it and sell the service as part of their more comprehensive maintenance

offering. Dale thought it was a great idea and that it needed a place in maintenance contracts and plans, a place where it was expected to be performed and documented and used with customers to get problems resolved.

Donald Prather, ACCA, commented that he'd spent a lot of time working on commercial rooftop units trying to measure airflow through economizers in California. He'd also worked with the folks from ACCO who also didn't seem to have a method for doing it either. Don stated that he thought those instruments gave you feet per minute readings but not average feet per minute over the entire duct area, just from a sample location. It was really hard to get an accurate reading unless you worked with a unit which had a built in flow station. That might be a way that California might want to support. Then, you could get an accurate reading with just a pressure meter.

Rob Falke disagreed and thought that with the right instrument it was very easy to do and was being done frequently around the country right now. He had complete confidence with the contractors they'd trained and when they used the right instruments.

Don Prather countered stating that Standard 111 wouldn't support the hot wire anemometer sample approach Rob had just described. Especially in VAV systems. There were a lot of variables the group hadn't even discussed yet.



Rob asked Donald whether this was covered in ACCA Manual B. Donald responded that it was. But, he was convinced that it wasn't as easy to come up with an accurate reading as was being stated in the meeting. He was not against taking the measurement and was all for taking whatever data could be collected. He was just hesitant to have the group believe that accurate measurements could result easily and in all cases.

Pete Jacobs, Chair, believed that this was a very important issue to work through. Measurement techniques was a part of the topic they'd planned to address. He expected it should be continued in the follow-on working group that would focus on how measurements needed to be taken and what calculations should be used to evaluate the collected data. He thought it was both valuable and vital to continue but wanted to table it here because it was an issue that wouldn't be solved in this working group. to focus on what data measurements were needed.

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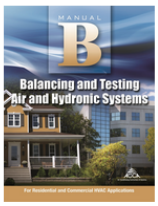

Manual B - Balancing and Testing Air and Hydronic Systems

Description

Manual B covers:

- HVAC components from a TAB perspective.
- TAB tools that are available.
- Documentation needed to begin and complete a TAB project
- How to apply the scientific principles of air to the TAB process
- Balancing airflow
- Balancing hydronic systems

Problems encountered in the field, and warnings on commonly made mistakes are highlighted in the manual. Additionally, technicians can use the information provided in the manual to improve their diagnostic skills and understanding of how HVAC system operate. As a bonus, Manual B provides sample forms that can be copied and used to document balancing procedures and the equipment data needed to complete an organized and well documented TAB report. Guidance on the specific information that needs to be included in the final report is included in the balancing sections for the individual types of equipment.

<u>Pete solicited comments regarding economizer repair tracking</u>

- Economizer Repair
  - Track repairs made
  - Functional test type
  - Functional test result
  - Other?

Dale Rossi wondered how inclusive this "repair economizer" was intended to be. There could be changes to the outdoor air minimum position, sensors might be replace, for example. What was the point for collecting this data. Would it be collecting what was wrong, what was done to fix it successfully? For what purpose? How would you use that data? If you weren't going to use the answer collected, why do it since there is a cost.

Pete Jacobs responded that he thought of this more as activity tracking than where some quantitative analysis would later be employed. It would make sense in a utility program where they were needing to track activities for which rebates or incentives would be paid.

Dale Rossi was very familiar with those utility program uses. They'd need the original replaced controller model number and the replacement one too. The same for changeover sensors and all the other components. The minimum position settings and others might also be necessary for energy savings estimations.

Rob Falke offered that from the air side you might need to estimate the number of BTUs coming in through the economizer. That's why you'd need to capture the airflow and outdoor air temperature to determine unit efficiency.

Pete Jacobs was pleased with the discussion. Great input about when performance measurements were necessary, reasonable data collection intervals. He was intrigued by the comment that every commercial maintenance call was a new look. The idea of a unit sticker or linking information back to a utility to maintain where a program was concerned were all better than what was described.

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Dale Rossi cautioned about having any information stored by a utility. Contractors were not wanting to supply customer sensitive information. That could involve legal issues. The sticker on the unit didn't require permissions. When the current service provider goes away, the permission goes away too.

Pete Jacobs asked Rob Falke and Dale Rossi about any capability they had to transfer HVAC unit data since both their firms offered software solutions. When someone new picked up an account, does the information get transferred over, could it be transferred over?

Rob Falke commented that in their situation, the contractor was considered the owner of the data. They could choose to share some of that with a utility but definitely not all of it.

Dale Rossi thought that data ownership could be litigated. Utilities would tell you they own the data. Contractors would tell you the same. Generally, a contractor didn't want to share their customer list with anyone who might share that information with others, competitors. Dat security, privacy was a very important issue.

Pete Jacobs thought that the issues around how measurements could, should be taken and instrumentation could probably be addressed by the planned follow-on working group. That would include issues around quasi-steady state field conditions. Timing, which data needed to be collected simultaneously or nearly so.

Pete asked that the version 4 specification that had just been delivered prior to the meeting be reviewed by all members. He asked everyone to provide him with their comments so he could revise it again before they met next. He wanted to focus on what data was appropriate for which activities before the next meeting.

Dale Rossi asked Pete to provide a definition for columns E and F of draft version 4 on the In-Field Test Data tab labeled Commercial Maintenance Performance Benchmarks and Commercial Maintenance Diagnostics. Which on addressed the annual maintenance process? He assumed that column E "Benchmark" referred to when you went to a unit for the first time, you'd attempt to benchmark its current performance. He thought column F "Diagnostics" would refer to the heating/cooling seasonal start-up calls. He could imagine another column related to diagnostics for specific problems you'd encounter during maintenance calls. Outside of normal maintenance and probably in that realm of the service/repair category.

Pete answered that the initial unit benchmarking data was listed under column C. Column E was intended for on-going benchmarking data collection measurements that might occur on an annual or every other year basis. The data collected on a quarterly or semi-annual basis was listed in column F - "Diagnostics." That might need to be broken out better. He asked all to comment on this.

Dale commented that the mid-season quarterly tasks involved almost no data collection. Mostly just inspection tasks. Column E benchmarking was not a practice which currently existed except where a utility program might require it. He thought those practices, measurements were the ones performed during the seasonal heating/cooling start-ups already intended to be captured in column F.

The group concluded that the column designations were not clear and needed better definition or revision. Rob Falke and Dale Rossi volunteered to work on an improved revision off-line.

ACTION: Rob Falke and Dale Rossi volunteered to meet off-line and work on revisions and definitions for columns C, E & F to offer a better way to capture initial assessment, ongoing assessment and measurements which needed to be taken during deeper diagnostic investigation, typically on service/repair calls, not as part of scheduled maintenance.

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Closing Comments/Adjournment

Pete Jacobs thanked everyone for making the meeting and for the great input. He asked that everyone review the spec. spreadsheet and either enter comments into the last column and sent it to him or just email general comments before the next meeting. He asked Bob Sundberg to again provide an online poll to determine the best day/time during the week of December 14 to 18 for what would probably be their last meeting.

The meeting was adjourned at 11:06 am PST.

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Summary of Pending and New Action Items and Key Decisions

Dec. 4 ACTION: Pete Jacobs would revise the draft spec. to include refrigeration measurements be taken during commercial maintenance performance benchmarking.

Dec. 4 DECISION: Agreement that defining maintenance tasks and/or airside measurements that when analyzed could provide a pass/fail indication for performance would be an asset to providing a cost-effective trigger for further appropriate system investigation.

Dec. 4 ACTION: Rob Falke and Larry Smith would work together over the next couple of weeks to identify recent jobs where full before/after evaluation data was collection for Standard 180 program customer units. Rob offered to pull the data and share the data and analysis with this group to demonstrate the impact of Standard 180 based maintenance and their approach to data collection and analysis.

Dec. 4 ACTION: Dale Rossi volunteered to send out his specification which defined evaluating condenser coils and provided guidelines for under what conditions he'd determined that a coil needed to be cleaned.

Dec. 4 ACTION: Rob Falke and Dale Rossi volunteered to meet off-line and work on revisions and definitions for columns C, E & F to offer a better way to capture initial assessment, ongoing assessment and measurements which needed to be taken during deeper diagnostic investigation, typically on service/repair calls, not as part of scheduled maintenance.