



## Goal 2: Commercial Quality Installation SFDS Working Group Wednesday December 15, 2015 Meeting Notes

### Call to Order

The meeting was called to order at 1:04 pm 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. 12 of 23 voting members, 2 non-voting members and 1 guest/staff attended this meeting. A total of 15 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	P
CDH (CDH Energy Corporation)	Hugh	Henderson	Energy Efficiency Organization	
Clean Energy Horizons, LLC	Norm	Stone	Energy Efficiency Program Consultant	P
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	
Energy Solutions**	Jim	Hannah+	NR	P
FDSI (Field Diagnostic Services Inc.)	Dale	Rossi	Third Party Quality Assurance Providers	P
Galawish Consulting & Associates	Elsia	Galawish	Energy Efficiency Program Consultant	P
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	P
PG&E (Pacific Gas and Electric)	Adam	Scheer	California IOU	P
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
PG&E (Pacific Gas and Electric)	Leif	Magnuson	California IOU	
PG&E (Pacific Gas and Electric)	Robert	Davis	California IOU	
SCE (Southern California Edison)	Lori	Atwater	California IOU	
SCE (Southern California Edison)	Steve	Clinton	California IOU	



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SCE (Southern California Edison)	Andres	Fergadiotti	California IOU	
SCE (Southern California Edison)	Sean	Gouw	California IOU	
XCSpec	Jeff	Aalfs	Controls (Manufacturer or Distributor)	P
<b>WHPA Goal 2: CQI Committee Invited Guests and Staff</b>				<b>Roll Call</b>
<b>STAFF</b>				
BBI (Better Buildings Inc.)	Dale	Gustavson	WHPA Executive Advisor	
BNB Consulting/WHPA Staff, host, admin. support & scribe	Bob	Sundberg	WHPA Staff	P
Empowered 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

<b>AGENDA</b>		
<b>Topic</b>	<b>Discussion Leader</b>	<b>Desired Outcome</b>
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.
Review feedback from Dec. 4 meeting	Pete Jacobs	All feedback shared with working group.
Scope of remaining WG effort	Pete Jacobs	Understand the focus for the limited remaining WG time.
Review rev. 5 Spec. spreadsheet	Pete Jacobs	Understand current rev. 5 spec. spreadsheet changes.
Discuss further revisions to rev. 5 Spec. spreadsheet. Assess degree of additional effort needed to finalize.	Pete Jacobs	Determine what is still needed to finalize Spec. spreadsheet as a "work product." Decide on next steps.
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.



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### Approve Minutes of Previous Meeting

The December 4 meeting draft notes were distributed December 3. 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.

### Review Status of Action Items from Previous Meeting

Dec. 4 ACTION: Pete Jacobs would revise the draft spec. to include refrigeration measurements be taken during commercial maintenance performance benchmarking. Completed, shared at the meeting and distributed to all afterward.

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. Agreed.

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. Pending.

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. Pending.

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. Pending.

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.

### Welcome New Members and Guests

Leif Magnuson, PG&E will be joining this WG going forward. He was unable to make the Dec. 15 meeting. Lori Atwater, SCE, recommended he participate because of their shared interest in residential HVAC IOU programs.

### New Business - Pete Jacobs

None.

### Review of WG progress, focus and goals - Pete Jacobs

Pete Jacobs, BuildingMetrics Inc. (BMI) and Chair, had prepared a PowerPoint presentation to help guide the group through comments received and their review of the data specification draft. He'd also received some last minute comments which delayed his getting a revised data specification out to the group in advance of the meeting. He would incorporate those pre-meeting comments as well as those made during the meeting and distribute a revised specification spreadsheet following this meeting.



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### Slide 2 Working Group Objective

Their goal was intended to be completed by the end of December. Pete took a straw poll and all attendees indicated that they'd try to attend the week of December 28, especially during the first three days. Several indicated they'd be away for the holidays or traveling but would try to call into the meeting.

- Define and standardize field data collection relating to system performance measurement and evaluation
  - Program tracking
  - Impact evaluation
  - Customer savings calculations
- Cross-committee applicability
  - Residential installation
  - Commercial installation
  - Commercial maintenance
  - Energy savings and DEER

Pete reviewed the WG scope, type of information intended to be captured by this data specification as well as the cross-committee intent and applicability. CQI, RQI, CQM and Energy Savings and DEER committees. Their primary and first goal was to define and standardize the field data which needed to be collected in order to evaluate unit and system performance and with a first area of activity being commercial equipment installation. This data would be critical to providing pre/post evaluations in order to determine any energy savings attributable to an activity. This would be valuable for California utility program use as well as more generally between service/installation providers and their customers. The intent was to allow building the data needs into the process for utility program development. That would allow program participants and utility and CPUC/ED program evaluators to use a common and standardized approach for HVAC equipment and system performance evaluation.

Pete Jacobs also made clear that this WG was not intending to supersede or re-write any existing standards. It was a focus on a subset of data believed to be valuable for future program tracking and evaluation and on savings calculations. The focus was on data elements, not yet on methods for calculations or protocols. What data was reasonable to collect in the field that would be valuable for the methodology discussions which would come later.

His major take-away from the previous meeting was that there was still some discomfort with this being a cross-cutting, cross-committee activity. He probably should have contacted the chairs of the other three committees directly early on to discuss what was intended for the WG. He'd attended the other committee meetings to report the planned activity but hadn't spoken with each chair individually. Going forward, they would re-address whether this committee would continue to lead a cross-committee activity or whether the other individual committees would take up work on the data specification related to their specific area of interest building on what this WG had produced. His preference was to have this WG produce cross-cutting output. He intended to circle back with the other committee chairs to discuss what made the most sense going forward.

**ACTION:** Pete Jacobs would contact chairs and/or key committee members to discuss how best to proceed with cross-cutting efforts toward additional data specifications relevant to residential installation, commercial maintenance and the Energy Savings and DEER Committee.

Adam Scheer, PG&E, had attended a recent Energy Savings and DEER (ES&D) Committee meeting. The ES&D Committee meeting focused on a 2016 goal of producing a white paper looking at a full HVAC unit measurement approach. There had been a lot of talk at the WHPA In-Person meeting about the need to produce a more holistic approach on energy savings impact evaluation rather than the current energy efficiency measure by measure approach. The ES&D chair believed that his committee was tasked with how that might be done. Adam assumed



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that determining what kinds of data needed to be collected was an important preliminary step in order to do an evaluation. He asked about whether Pete or others thought this committee's efforts were parallel to theirs or somewhat of a duplication and potential overlap?

Pete Jacobs thought that this WG effort and output could be very useful and completely compatible with the ES&D activity. Their WG effort might even reduce the data determination effort that the ES&D Committee would face. This WG was also looking closely at what was reasonable to expect for field collected data which would also be very valuable to have addressed.

Bob Sundberg, WHPA staff, added that from his work supporting the CQM, RQI and CQI committees, he'd seen those three having tackled a unit measurement approach vs. the current energy savings measure by measure approach for a number of years, well ahead of these recent ES&D Committee discussions. It was pretty likely that the chair and many members of the ES&D Committee were not fully aware of the ground and issues already covered and being worked by those other committees. It was also his understanding that the ES&D Committee, just formed in 2015, had spent a fair amount of the year gaining an understanding of how the CPUC/ED evaluated IOU claimed savings, what DEER was and how it was used. The ES&D Committee was formed to collect the specific issues each of the other focused committees had identified and work those common issues with the CPUC/ED. Also, the goals discussed at the In-Person meetings November 4 & 5 would be considered toward overarching Smart Goals for the entire WHPA. The breakout group proposed goals would be used by the Executive Committee (EC) to help guide and coordinate more specific and detailed goals each committee proposed. Committee and working group goals for 2016 were still in a developmental period, not yet established or approved by the EC. He wasn't sure how the ES&D Committee efforts would mesh with CQI Committee goals proposed a year ago and worked during 2015.

Pete Jacobs agreed that their WG data specification effort could help the ES&D Committee get off to a quicker start. But, once they got to working on methods and determining performance evaluation calculations, there could be a fair amount of duplication with what the CQI and the other committees were already working. He thought the chair probably needed to take a tour around the other committees and check in on what the others were already doing before finalizing what his committee's role should be. There was certainly some useful work that ES&D could focus on that the other committees might not want to take on. They'd all need to do some coordination once this WG got past the data specification stage.

Rob Falke commented on what he thought they were now seeing. This new frontier that each of the committees was trying to address. It just hadn't been possible to succeed in getting approved IOU program energy savings under the older, existing measure by measure methods based on layers of assumptions and discounted implementation. The programs that based claimed energy savings on existing standards, though the standards themselves were great, were just coming up short in getting approval or confirmation for savings. The result was that many of the key programs were evaluated as not being cost-effective and, though supportive of state strategic plan objectives, were increasingly hard to justify given the cost of operating the HVAC programs. The hunt was on to take those existing standards and add a performance dimension to them that would allow a way to quantify energy savings the programs were actually delivering. He thought that there was a lot of potential synergies by the various committee efforts as they moved forward.

Dick Lord, Carrier Corporation, commented on the standards which were based on laboratory based and controlled rating conditions for performance evaluations which he didn't believe could be duplicated in the field. Most HVAC equipment went through very extensive rating procedures under stable and standardized conditions. All of the factors and elements that effected stable conditions under which to conduct performance, like barometric pressure and relative humidity, couldn't be created under varying field conditions.



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Rob Falke responded that he understood that manufacturers published performance results under a variety of laboratory controlled conditions. The measurement done in the field was intended to determine the net BTUs delivered into the building. What the customer received. The delivered BTUs was divided by the equipment rated BTUs. Entering wet bulb temperature, CFM/ton of rated equipment capacity and ambient outdoor temperature were the elements taken into account.

Dick Lord asked how the field measurement approach addressed field conditions difference from rated conditions. He didn't understand how you could compare to the rated capacity if you ran the equipment under different conditions. You wouldn't be running the system under the same static pressure or barometric pressure conditions. If you were off 10% from the rated capacity, how would you know why you were off 10%?

Rob Falke said that they didn't use any correction factors. Just a determination of what actual net BTUs were delivered into the building by the equipment and delivery system.

Ben Lipscomb, NCI, clarified that Rob was just describing measuring performance at the conditions encountered in the field. They then would look at the manufacturer's extended performance tables based on the three factors Rob had listed. This would list what the manufacturer indicated the HVAC equipment should deliver in a lab at those conditions found in the field. They were not looking at the published maximum EER or published capacity. Dick thought the explanation was very helpful. The only factor it didn't seem to address was correction for barometric pressure, a significant factor in high elevation locations like Denver. Barometric pressure had impact on condenser performance and indoor supply fan power. Rob Falke added that some of the software used did provide corrections for barometric pressure variance.

**KEY UNDERSTANDING:** Field measurement comparisons would make use of equipment manufacturer's extended performance tables with ratings at different combinations of conditions, not a simply comparison against a single maximum rated EER.

The discussion reminded Dick Lord of which white paper he'd intended to provide the group. He was relieved that their performance comparisons were against extended rating tables, similar to the efforts in ASHRAE Standard 205. Expanded equipment ratings in a standardized format.

**Purpose:** To facilitate sharing of equipment characteristics for performance simulation by defining standard representations such as data models, data formats, and automation interfaces.

.....trying to make a standard way for manufacturers to provide performance data at various operating conditions for different types of HVAC&R equipment. This data would be used to perform energy simulation in tools like (but not limited to) eQuest and EnergyPlus. (from Project Haystack at: <http://project-haystack.org/forum/topic/116>)

<http://spc205.ashraepcs.org/> SPC 205 Home Page

<http://spc205.ashraepcs.org/membership.html> SPC 205 Membership

Rob Falke thought that there was value in each of the related standards. The work of this working group was to harness and use each to accomplish their goal over the next couple of working group efforts. Measurement in the field will never approach what was possible with laboratory controls where they would attempt ratings down to the tenth of 1%. Field issues would be cruder, attempting to impact efficiencies commonly delivered to the space as much as 40% below maximum equipment ratings. So, the same level of exactness wasn't really the goal here. This



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performance approach to testing helps a contractor become aware of large problems and begin a process of addressing the issues that caused the loss of performance. Then, testing the system again after corrections to verify if they'd made an improvement.

### Slide 3 - FOCUS ON COMMERCIAL INSTALLATION

Pete proposed that their remaining time and effort be focused on a data specification for commercial installation.

- Focus on subset of data required for system performance measurement and evaluation
- Build evaluation needs into the program data collection activities
- Not intended to supersede existing standards
- Focus is on data not methods

### Slide 4 - Major takeaways from Dec. 4 meeting

- As a cross-cutting activity, needs more buy-in from relevant committees
- Meetings to hash out specific cross-cutting coordination issues to be scheduled (including action items from last meeting)
- Focus for today on measurement activities related to CQI

### Slide 5 - Context for this WG - Three related CQI Committee Performance-Based Goals

Goal #3 – Support a cross-cutting working group to develop a Field Data Collection Specification.

Goal #4- Develop a standardized, repeatable performance-based method for system evaluation.

Goal #5: Publish a HVAC system performance verification (commissioning) process that could be proposed to constitute a standard verification approach.

Pete Jacobs summarized that the three CQI Committee proposed goals lead to a performance-based test method to verify HVAC energy savings.

Rob Falke supplied several slides to help describe a proposed approach to commercial performance verified installation.

### Slide 6 - Commercial QI

- Renovation addresses air-side deficiencies
- Commissioning establishes correct installation procedures and benchmarks system performance

Rob described a bit about the SCE commercial renovation program his firm helped support. They had a contractor forum planned for later in the week which involved about 70 contractor firms. They'd been gathering installation performance data for about three years from a pilot and related efforts. Their SCE efforts not only addressed proper installation procedures but also identification of airside delivery system deficiencies which needed to be corrected in order to allow the equipment to deliver its maximum efficiency to the space.

Commissioning included many of the test/measurement points this group had discussed. But, their renovation program tried to go beyond commissioning to rate a system performance before replacement (benchmark data) against measured system performance after equipment installation and delivery system corrections were made.

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### Slide 7 - Typical Existing HVAC Residential and Commercial System Performance



The graph shared a performance ratio between system delivered BTUs to the building space divided by equipment rated capacity in BTUs. A typical system only delivered about 60% of the equipment rated BTUs the equipment was capable of producing to the building space. Most utility programs didn't look at delivered performance. This airside approach test-in approach identified additional defects in the system delivery system in addition to addressing proper installation.

Norm Stone, Clean Energy Horizons, asked Rob where most of those efficiency losses occurred.

Rob Falke replied that there were about 40 different system repairs which could be responsible. A given repair might have an impact of 40% or as low as 3% depending on how different systems had been installed. The culprits varied widely. Each system seemed to be an individual case. But, locating those causes seemed to be most easily accomplished through airside diagnostics.

Ben Lipscomb, NCI, stated that they'd found that in about half of the cases, they'd found the equipment was not operating as it should. The other half of the cases, the major factors involved the distribution system.

Rob Falke added that many of the equipment performance issues were caused by the way the distribution system had been designed and installed. It caused the equipment to perform far below its capability. Overly restrictive duct systems, improper fan selection matched to drive air against that higher static, for example. Once the airside issues were corrected and equipment issues addressed, the refrigeration cycle evaluation could be done. It really involved a holistic approach as had been mentioned earlier. Existing standards seemed to focus on parts of this system to determine whether that part was working correctly. But, this groups and the other committee efforts were far more focused on the entire system and the total end result. A performance approach seemed to him to identify a lot of system issues which were just invisible using piece-meal approaches of the past. It could have been a condenser problem, controls, fan and/or airflow, a whole host of possible causes that need to be considered.

Norm Stone asked Rob how they went about deciding which performance measurements needed to be taken?

Pete Jacobs responded that Rob was giving an overview. Those specific points and measurements were already listed in the specification which they'd take a closer look at shortly.

Donald Prather, ACCA, said he almost hated to say he agreed with Rob Falke's comments but that Rob was 100% correct. The mention of those statistics reminded him to mention the IEA Annex 36 NIST heat pump fault impact study findings. Airside performance evaluation was not covered. But, it did include low charge, over and under sizing equipment and other problems known to occur during installation. They evaluated individual fault impact as well as multiple simultaneous fault impact. Some faults compounded their impact, were additive, while others



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were not. The bottom line was that there would be a large loss of efficiency which the equipment was capable of out of the box if not installed properly which included doing a full commissioning. He estimated somewhere around 30% to 40% loss of efficiency would be pretty common which aligned well with the NIST study results and what Rob had mentioned.

WHPA RQI Committee site link to NIST study located at the RQI site:

<http://www.performancealliance.org/Committees/Goal2QualityInstallationMaintenanceCommittee/ResidentialQICommittee/tabid/270/Default.aspx>

under Supporting Documents:

<http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1848.pdf>

Access to IEA NIST study from ACCA site:

<https://www.acca.org/communities/community-home/librarydocuments/viewdocument?DocumentKey=4bd83c8b-1c93-4743-989e-40f7422aef35&tab=librarydocuments>

### Slide 8 - Performance Testing - Hidden System Failings

Rob Falke stated that there certainly were many kinds of problems related to new system and equipment installation. He thought they were all moving closer to trying to find ways to score system performance both before and after installation and system improvements.

- Equipment capacity below specifications
- Defective distribution systems
- Curb restrictions
- non-functional economizers (83%)
- Poorly performing refrigerant circuits and combustion performance
- Excessive distribution losses

Dick Lord, Carrier, asked how current the economizer system data was. There'd been a lot of changes to economizers including introduction of digital systems recently. Most had displays which told technicians when something was wrong.

Pete Jacobs indicated that he knew DNV-GL was evaluating economizer system functionality as part of their IOU maintenance program evaluations. The hvac1 study was including evaluation of economizer systems for Upstream program new equipment installations. A lot of systems included the new digital economizer systems, so it would be interesting to see what those studies found.

Jarred Metoyer, DNV-GL, indicated some effort was underway to provide some of the data in addition to the reports. Dick Lord indicated that industry would be very interested to see those findings. Some data might be available Q1 2016.

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Slide 9 - Typical Residential & Commercial HVAC System Performance Improvement

After upgrades and commissioning? Systems are improved, on average, to near 90% performance.



Slide 10 - HVAC System Renovation - Essential to Achieving Reasonably High Efficiency

HVAC System Commissioning provided:

- Equipment measured performance
- Accessory measured performance
- Distribution system measured performance

Slide 11 - HVAC System Commissioning

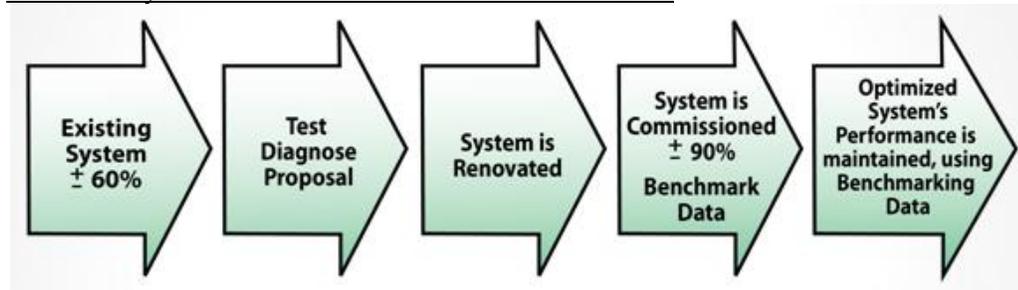
Renovation alone produced inadequate levels of performance.

HVAC system commissioning is required at completion to optimize system performance.

Conclusion:

Renovation, upgrades and commissioning were pre-requisites to an effective HVAC energy efficiency program.

Slide 12 - System Performance and Maintenance Process



First: the system has been renovated and optimized

Then: the level of performance achieved can be maintained using benchmarking data collected during the commissioning process. This benchmarking data can stay at the unit as the CQM MTWG had recommended.

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### Slide 13 - Airside Performance Diagnostics

Airside performance diagnostics search for telltale changes that may indicate a decrease in performance by measuring:

- Total External Static —→ Change in Airflow
- Coil Pressure Drop —→ Coil Cleanliness
- Supply Duct Pressure —→ Supply duct system defects
- Return Duct Pressure —→ Return duct damage
- Fan RPM —→ Change in airflow
- Temperature Change —→ Refrigerant or combustion

Rob Falke indicated that it would be too time-consuming and expensive to take these measurements on all maintenance calls. But, when these measurements could be taken, they could be compared back to the benchmark readings recorded at the unit as the CQM MTWG had recommended. Any significant change would indicate a serious system issue and drop in overall performance. Rob added that when the airside full system measurements were taken, a field measured EER rating was determined and recorded within the SCE commercial renovation program they supported.

Norm Stone, Clean Energy Horizons, asked whether electrical use was also included in this approach. He thought that with all those airside adjustments and the performance improvement, that should translate into a reduced HP to deliver that capacity. Something had to deliver energy savings.

Dale Rossi, FDSI, took issue with Norm's about taking electrical measurements, the assumption that the result of improved performance would be reduced HP to deliver the capacity statement. His experience was that as equipment performance degraded, capacity degraded but that electrical usage, demand in kW, remained relatively constant. The consumption over time, kWh, would likely increase from degraded capacity and increased runtimes but not the instantaneous usage.

Rob Falke shared that they'd found that a typical system had a 40% increase in BTU output with only about a 2% increase in instantaneous power consumption (current draw).

Ben Lipscomb, NCI, added that the increase in BTU output would result in reduced runtimes, reduced kWh consumption over the course of the year. He knew of one situation where there could be a significant change in power use. If a duct system needed to be renovated to allow substantial increase in return airflow, you'd normally then see an increase in the power use of that supply fan. You might be able to go back and reduce the RPMs for that fan to meet the manufacturer's specified airflow. That would amount to a power use reduction.

Dick Lord, Carrier, offered that in commercial buildings where ventilation was required during all occupied periods, the fan energy consumption could amount to as much as 40% of total HVAC electrical usage. So, getting supply fan speed and power consumption right had a big impact. Even when cool systems had compressor unloaders and could reduce compressor energy consumption, the fan power use would be constant.

Dale Rossi thought that faulty economizers along with duct leakage were the major contributors to unnecessary infiltration and increased load.

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### Standardized Field Measurement Data Specification Related to Commercial Installation - Pete Jacobs

Pete Jacobs proposed that the group then focus on the data specification version 5 which had not yet been distributed. He shared the spreadsheet online from his desktop and suggested they focus on the columns related to commercial installation on the In-Field Test Data tab. He'd added several measurements from comments Donald Prather had sent in.

He asked Rob or Ben to comment on the airside pressure or airflow measurements needed at time of installation compared to those suggested to be check on an ongoing basis.

#### Airside Pressures

Rob indicated the three pressure measurements marked with red X where necessary to calculate system performance. Those included 4.8 equipment entering pressure, 4.9 equipment exiting pressure and 4.14 fan pressure.

The group discussed entering filter pressure, one of the optional measurements.

- Dale Rossi commented on this being a good example of the different industry perspectives. Airside test and balance folks would prefer almost no filter restriction to maximize airflow. Maintenance or health conscious consumers would want filters with far greater restriction to keep evaporator coils clean and/or remove objectionable airborne particles. A balance was always needed between these two apparent conflicting goals. Fan speed also had to be considered and adjusted if there was a great change in filter treatment.
- Donald Prather offered that this pressure reading could be one of the Standard 180 condition indicators written into a maintenance plan to determine when a maintenance task, filter change, needed to be done or not. MERV 8 was what was now being called for in ASHRAE Standard 62.1 and 62.2 and that seemed to keep increasing.
- Chris Ganimian, Energy Analysis Technologies, commented that with the advent and increased use of variable speed high efficiency ECM supply fan motors in residential systems which could adjust speed based to maintain airflow, some manufacturers were advocating filters with much higher MERV ratings which greatly restricted airflow and static pressure. This wasn't as common an issue in commercial.
- Dick Lord, Carrier, mentioned that the Standard 62 people didn't care about energy efficiency. They cared about indoor air quality. The greater filtration, the better. Getting a balance was always a battle. Labs and the LA airport were now using carbon filters which had extremely high pressure drops.
- Dale Rossi, FDSI, reminded the group that it was important to keep in mind when system performance measurements would be taken. Right after a filter change, the pressure readings should be near the benchmark. But, down the road when the filters loaded up, you would expect to see a much greater pressure drop. Performance would have dropped off. Dale described the interval data analysis from smart meters which AB 802 seemed to be leading energy savings analysis towards.

Pete Jacobs thought that a discussion on smart meters and meter based energy use/savings analysis might be something which the Energy Savings and DEER Committee could address. He wanted to have this group focus back on the specific data measurement points needed for performance evaluation. Another way to approach energy savings from the equipment level perspective of this group.

Rob Falke thought that the meter might be used to help determine energy savings, but it couldn't help diagnose what was wrong with a system and what elements needed to be corrected. Evaluation at the unit level could address that critical need. The process this group was working toward could provide the diagnostics as well as the verification output that was needed.



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Rob pointed out the red X'd measurements under the Airflow section which, again, were the measurements required for performance evaluation. Measurements 4.15 through 4.22 and 4.29.

Pete Jacobs asked about the Xs in the Commercial Installation Diagnostics column which referred to individual as well as total register (supply air) and grill (return air) airflow measurements. Was that intended for initial installation only?

Rob Falke responded that those extensive measurements were necessary to determine full supply air and return airflow. They were time-consuming at the point of installation and part of their commissioning a system. Supply fan airflow minus (-) total register measured airflow would reveal supply duct leakage.

### Economizer

Donald Prather, ACCA, questioned the value and even the accuracy of snapshot measures of economizer damper leakage and minimum airflow. The same dampers in the same fixed positions (minimum position) had radically different outdoor air intake volumes depending solely on which side of the building they were located.

Pete Jacobs suggested to the group that outside air and economizer related airflow measurement and methods was an important topic and would probably warrant a dedicated future meeting.

### Airside Temperatures (Db - heating mode only)

Rob Falke indicated that measurements 4.35 through 4.46 were required to calculate performance and were indicated with red Xs in the commercial installation (commissioning) column. Most folks would expect the system temperatures. There were quite a few system temperatures added. They'd need to address how to take those tricky average return and supply temperatures in the next working group which would zero in on measurement methods. He acknowledged that it was very difficult in the field to take accurate mixed air wet bulb and dry bulb measurements.

### Electrical Data

Data measurements 4.47, 48, 49 & 54 were required to determine system performance and had red Xs in the commercial installation (commissioning) column. Power factor correction and true RMS needed to be addressed.

### Refrigerant System

Rob Falke explained that they didn't have any Xs for measurements in the commercial installation column, which probably reflected how this was approached in the SCE commercial renovation program. They didn't tap into the refrigerant system unless the airside measurements indicated an issue in this area.

Bob Sundberg, WHPA staff, questioned why there were no Xs in the commercial installation column.

Pete Jacobs explained his reasoning that those measurements would not normally be taken or required unless there was an indication from the airside readings of a probable refrigeration cycle issue.

Bob suggested that an explanation like Pete had offered be added. Possibly (X)\* be added to each with the explanation that these measurements needed to be taken at installation if airside measurements indicated a probable refrigerant system issue to recommend conducting diagnostics.

Pete agreed with the point.



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Donald Prather, ACCA, commented that manufacturers had started putting only the minimum amount of refrigerant into systems. If a commercial system refrigerant line needed to be extended or the system was not charged properly, those measurements needed to be taken after the correct amount of refrigerant had been added. More of an issue with split systems than probably with packaged equipment. He was interested to see some red Xs in the commercial installation column to provide benchmark measurements. Maybe a "Pinto" test and another one a "Cadillac" test.

Chris Ganimian, Energy Analysis Technologies, suggested that when you took and compared measurements from the air side to those taken from the refrigeration cycle, you would be more confident that the system was operating properly. He'd found that when those comparison numbers didn't match up, it was likely that he'd made or recorded a measurement incorrectly.

Dale Rossi, FDSI, added that because of difficulty with measuring things like RH and airflow accurately in the field, they'd found that the refrigerant side measurements of capacity were more precise than the airside capacity measurements if you were using computerized software tools like the HVAC Service Assistant.

### Combustion System

Rob indicated that all five measurements were taken during commercial installation but were not required for system performance evaluation. There were considered diagnostic measurements to identify if there were system issues that needed to be addressed.

### Safety Checks

Donald Prather had suggested they add these checks as a reminder to technicians. These had been revised and some added to the rooftop unit maintenance task tables by the CQM Maintenance Task Working Group's report for the same reason.

### **Closing Comments/Adjournment**

Pete Jacobs wanted to get some clarity on how to name or address several of the columns (commercial diagnostics column included) before sending out a revised spec. spreadsheet. He wanted to circle back with Rob and Dale

Dale Rossi suggested something other than colored X marks which he couldn't read. Pete agreed to address a better way to address the distinction.

At the request of Dick Lord and Pete Jacob's approval, Bob Sundberg sent Pete's meeting presentation and the specification revision 5 out to all members and guests right after the meeting. Completed.

Pete Jacobs brought up another issue he wanted to address at the next meeting. There were a number of airflow "measurements" which were actually determined as a result of calculations from other readings. The question was whether they should include those in the work of this WG or defer that to the next WG which would focus on methods for measurement, calculations and determining a standardized protocol. Should the data spec spell out the intermediary measurements like duct dimensions and method of determining air velocity necessary to determine airflow? That was an important decision to make. He asked everyone to consider that decision for the next meeting.

Pete requested Bob Sundberg send out another online poll to determine the best day/time for the last 2015 meeting the week of December 28. Completed.



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Pete also thanked everyone for their attendance, attention all the great input for the group to consider.

The meeting was adjourned at 3:01 pm PST.

\* \* \* \* \*

### Summary of Pending and New Action Items and Key Decisions or Understandings

Dec. 15 ACTION: Pete Jacobs would contact chairs and/or key committee members to discuss how best to proceed with cross-cutting efforts toward additional data specifications relevant to residential installation, commercial maintenance and the Energy Savings and DEER Committee.

KEY UNDERSTANDING: Field measurement comparisons would make use of equipment manufacturer's extended performance tables with ratings at different combinations of conditions, not a simply comparison against a single maximum rated EER.