Regional Technical Forum Meeting Notes

February 20, 2007

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1. ***Greetings and Introductions***.

The February 20 meeting of the Regional Technical Forum was chaired by Tom Eckman. The following is a summary (not a verbatim transcript) of the topics discussed and decisions made at this meeting. Anyone with questions or comments about these notes should contact Eckman at 503-222-5161.

2. ***Update on Field Research Project***.

a. ***Delta Q Duct Tightness Protocol Validation***. Bob Davis led this PowerPoint presentation, noting that the purpose of this research is to develop an estimate of system leakage. There are holes in the system that experience different pressures when the fan is running and not running; the blower door essentially turns on or turns off leaks. When they are turned on, the leaks manifest as a difference in flow across the envelope, he explained.

Davis touched on the following major topics:

- What is Delta Q? A duct leakage measurement method that requires a blower door with automated control and specialized software; best-suited to existing construction.
- Sample data
- Method strengths – estimates supply and return leakage to outside at heating system's normal operating conditions; no additional math/measurements needed.
- Status of project: a total of six sites measured so far; two additional sites to be tested in March; results to be integrated with BRC report, with final memo to be prepared in April.
- Results so far (table)
- Logistics – test generally takes 1.5 hours, including setup and analysis; wind effects limited in sites so far (luck); no involvement of utilities/crews so far.

- Analysis – test relatively easy to set up and perform; analysis can produce significant differences, depending on inputs; test is known to be affected by wind; test format is still under development.

The bottom line, said Davis, is that the results show that Delta Q is still a beta product – it is still being argued over and developed slowly by a limited number of people. I would like to report a more optimistic result, he said, but that's the reality. We'll see what happens in the next few tests, said Davis. From a practical standpoint of having an installer crew do this test, I would have concerns about user choice of inputs, said Davis.

Have you compared your findings with what Paul Francisco and others are doing in their field tests in the Midwest? Eckman asked. Are they getting similar kinds of results? I haven't done a full review, but in discussing this with Paul, their results are not dissimilar, Davis replied. If you wanted to be optimistic, you could say that 70-80 percent of the time the comparison of Delta Q to best estimate is pretty reliable, and you would make the right decision to seal. The problem, especially for a method you wanted to be able to hand off to a crew that has no real knowledge of how to run an analysis, if they always ran default mode, it might be OK, but sometimes it wouldn't be. Maybe a false negative 20-25 percent of the time is a reasonable risk, Davis said. Certainly the test we're using now also blows up, and we don't even know what percentage of the time, one participant observed. True, said Davis.

The bottom line is that, while I'm less optimistic than I was, I haven't given up, said Davis – it comes down to who's going to use it, and how confident the guy in the field is in his test.

If we look at application in existing homes, is the problem that you're getting plus/minus results, or is it that you don't know the magnitude as well as you would like? Eckman asked. In other words, are you going to catch the houses that really need to be sealed? Paul's conclusion is that you will, Davis replied; the frustration is that after all this time and development, why isn't it better? The test is supposed to use the house as a pressure vessel, and the leakier that vessel is, you should be able to tell what's going on. The current duct blaster test has significant error around the actual numbers when you have a leaky house and leaky ducts, Eckman observed – is the Delta Q test any worse, or is it perhaps better? Is it more susceptible to wind and testing error when you have a leaky house with leaky ducts? I would say Delta Q is more susceptible to wind, Davis replied. However, Paul has had some success in isolating wind effects when looking at the math.

Are the errors with Duct Blaster comparable errors? Ken Eklund asked. If we're running a program like Energy Star with PTCS duct certification, if we use one set of equipment and one protocol, at least we have consistent error built in, Davis replied. But if we start using two methods with different, incomparable errors, we

lose whatever standardization we have built into the program. With newer homes, with predominantly flex systems, the Duct Blaster method is probably getting closer to what's really out there, in terms of plenum pressures, Davis said.

3. ***Presentation, Discussion and Decision on Proposed Heat Pump Sizing Calculator***.

In the current PTCS specifications require a balance point calculation and computation of the size of the heat pump to use to the nearest half-ton, Eckman said. Bruce Manclark has tried to simplify this process on the assumption that getting people to do a "Good Manual J" heat loss calculation on a building to arrive at a total building UA -- is an oxymoron.

Rather than pursue that, said Eckman, it might make more sense to sort of back into the calculation by picking the building's vintage, identifying the window area and the type of windows in the building, and developing a look-up table that starts with a UA per square foot by vintage, based on what we think construction practices were at that time, let them specify window area and house size, and, based on the balance point they choose, that table would give them the tonnage of the heat pump.

Eckman then demonstrated the draft " Heat Pump Sizing Calculator" that he and Manclark developed. There are five house vintages, starting with pre-1979, he continued; each is associated with a specific UA per square foot. These UAs are based on the field research that Bob Davis did as part of the field evaluation of heat pump performance. Davis audited approximately 200 homes of various vintages in the study and calculated their heat loss characteristics, Eckman said, explaining how the offsets chosen were derived.

If the house has partially one type of window and partially another, do you have to enter that information manually? one participant asked. Yes, Eckman replied – you would do a weighted average by square footage. The next step is to pick a balance point between 25 and 35 for the system. Does this take climate zones into account? Another participant asked. No – by picking the balance point you're essentially picking the climate zone, Eckman replied.

So if a contractor in Missoula puts in a balance point of 35 F, and a contractor in Seattle does the same, the answer in both cases will be the same? another participant asked. Correct, was the reply. And you're factoring in the UA value, but what if a homeowner has done, say, an insulation package? Bruce Cody asked. You would pick a different house vintage if the building has been retrofitted, either insulation or windows, Eckman replied.

How would this be used? Grist asked. We would put it out there as a PTCS calculator, and the utilities could distribute it to their contractors in lieu of requiring a manual J heat loss calculation, Eckman replied. Have you factored in cooling at all? another participant asked. No – this applies to heating only, Eckman replied. Could we expand this to include an air conditioning calculator? Eklund asked. I suppose we could, Eckman replied. Could

we also extend the table to include a balance point of 20 F? Baylon asked. Yes, Eckman replied.

How many houses were in the pre-1976 portion of the study? Grist asked. Fifty, Baylon replied – the problem isn't the N, it's the standard deviation, which is driven by the number of retrofits.

After a few minutes of further discussion, it was agreed to add an air conditioning side to the calculator, as well as a more complete description of what is included in each vintage house package. We'll add these other bells and whistles and bring it back for further discussion at the next RTF meeting, Eckman said – our intent today was just to give you a first look and incorporate any suggestions you might have.

4. ***Presentation and Discussion of Recent Survey Data on New and Existing Residential Building Characteristics***.

There are actually three recent research projects that are coming to completion, said Jeff Harris: a residential new construction survey, some evaluation activities for Energy Star Northwest Homes, and the residential stock assessment. We're not quite done yet; the reports are still in final draft form. The numbers are pretty firm at this point, but we're still crafting the final language, Harris said. We felt that, given this body's task of assigning savings level to Energy Star homes, lighting etc., as soon as this data was ready to go, we wanted to get it in front of you, because it will influence your calculations down the road.

Using the overhead projector, Harris touched on the following major topics:

- Objectives: to update the 2000 new construction survey using a representative, statewide sample, to conduct on-site surveys comparable to the 2000 study, to examine the saturation of high-efficiency technologies such as CFLs, to analyze billing data.
- Sample framework: 2004 census permit data; 804 "completes." 604 site visits completed.
- Differences between 2006 and 2000 studies
- General characteristics of the surveyed homes
- Lighting: average of 50 fixtures per home, just under 2 bulbs per fixture, 77 sockets per home, more than double the 35 previously assumed for Energy Star homes. Only 6 of the 77, on average, are CFLs. The average number of incandescent bulbs per house is 62, so there is still a lot of opportunity to integrate more CFLs. There are 4.5 kW of connected lighting in the average Northwest new home.
- Water heating: 79% gas in new homes; instantaneous gas water heaters only 2% of the market. Electric storage is 13% of the market. The average energy factor for electric water heat is 0.9; the average energy factor for gas is 0.58.

- Appliances: 38% of clothes washers are MDF 1.8 and higher, which indicates that most new-home buyers are buying new clothes washers. Dishwashers: average energy factor in the sample was 0.54, just under the Energy Star standard. One-fifth of the new homes have two refrigerators, and some have three refrigerators.
- Cooling: 42% of new homes don't have cooling; five years ago, the exact opposite was true.
- Heating: forced-air furnaces account for 85% of new-home heating; only 7.2% of new homes have heat pumps with supplemental electric heat.
- Only 16% of heat pumps had an HSPF of 6.2 or higher – there is obvious room for improvement there.
- Digital thermostats are the norm.
- Windows: 20 years ago, 80% of the windows sold were aluminum-frame; in the most recent study, less than 1% were. About 89% of the windows in new homes have low-E coatings. In 2001, U-values across the states were in the mid- to low 0.4s. In the most recent study, the average is just below 0.4, for the first time.
- Air leakage: 225 of 264 homes received duct leakage testing. Results of blower door testing. The basic answer: divide by 20. The Lawrence Berkely labs official infiltration model predicts roughly 60% higher than field measurements of natural infiltration level. The blower door test is still valid. The average new home in the Northwest with a central forced-air system has an ACH 50 reading of 5.6. In the late '80s and early '90s, that number was close to 9 air changes per hour. In other words, air infiltration is no longer the 800-pound gorilla of heat loss it was 20 years ago.
- System air flow: for forced-air furnaces (gas), the average is just under 15 cfm per kBTU of output. For systems with AC, the actual measured airflow is only 294 cfm per ton. Airflow for air conditioners is significantly lower than manufacturer's specs show.
- Duct leakage: with no basement, 22% duct leakage is the average, vs. the measured airflow. That figure is cut in half for homes with an air conditioned basement. Absolute duct leakage per cfm per square foot of floor area averages 0.15 cfm50 divided by floor area. There has been a 60% reduction in duct leakage through the Energy Star homes program.
- CFLs: Idaho leads the way here. There were 103 homes with about 7,400 sockets/bulbs, split 50/50 between Energy Star and non-Energy Star, about 37 CFLs per house, in the study. The replacement rate was 4%, two-thirds of which were Energy Star bulbs. Energy Star lighting retention was good for these homes.
- The Residential Stock Assessment: an embedded study within the Distribution Efficiency Initiative Project, aimed at improving the distribution efficiency practices of utility distribution companies, specifically, at increased practice of conservation voltage regulation. The study collects statistically valid information on the key characteristics of the houses in the study.

- Sample data from the stock assessment, which will be completed in a couple of months: refrigerator characteristics, lighting, clothes washers, insulation etc. For example, the assessment found that the average existing single-family home has about 62 sockets, much higher than the 35 or 36 that was previously assumed.
- Participants were drawn from both sides of the Cascades.

What about hours of use – are you collecting any data on that? Grist asked. That's going to be really interesting, Harris replied – we're collecting data every 15 minutes. Signal theory may help us sort out loads, he said. We are going to do some conditional demand analysis on the data to sort out the benefits of conservation voltage regulation, he added. You might also get a clue by looking at the burnout rates, another participant suggested.

Eckman noted that the RTF will be taking up various pieces of this issue over the next several months, including duct tightness, duty cycle on lights for which there is no available data, and a variety of input assumptions for the modeling for both Energy Star and non-Energy Star homes.

5. ***Ground Source Heat Pump Research Update***.

Baylon led this presentation, noting first that this is essentially a quick analysis of engineering data provided by ClimateMasters, manufacturers of water-source heat pumps for applications in ground source. There isn't anything here that isn't in the manufacturer's specs, Baylon said – in other words, I don't have any data to back up a single thing I'm going to say.

We generated a load profile from SEEM, Baylon said; that load profile predicts how many hours the systems operate in heating and in cooling. The point of that exercise was to estimate how many hours the pump would be operating relative to the predicted performance of the heat pump in these conditions. These are summarized in terms of average COP for heating and EER for cooling. Baylon then provided some sample data from the 11 systems incorporated in the analysis. In conclusion, Baylon said that

- The open-loop "pump-and-dump systems", or any variation thereof, means you have to pay for the gravity via pumping. 300 feet is a lot more gravity than pipe pressure. Even so, performance is OK until there is a substantial amount of open loop.
- For closed-loop systems, the issue of shallow heat exchange significantly overshadows any of the issues with pumps.

There is a data set to be mined in the old Missoula study, Baylon said; one critical issue is the degree to which open-loop systems appear anywhere. Oregon doesn't want to allow open-loop systems, one participant observed.

The game plan here is to do an analysis that updates both the cost and performance of these systems – we haven't looked at them for six years, Eckman said. It would be a good idea to look at them again, since there appears to be a renewed interest in this technology. Bonneville needs to make a decision about incentive levels for ground-source heat pumps prior to the start of the next fiscal year, he added. We would like to get cost data prior to April 1, Adam Hadley said.

After a few minutes of further discussion, Eckman asked the other RTF members to look at the existing specs for ground source heat pumps and email any comments, questions or suggestions they may have to Hadley prior to the next RTF meeting. That way, he said, it might be possible for us to bring a recommendation to the meeting, rather than trying to edit them en mass.

6. ***Presentation, Discussion and Decision on Proposed Deemed Savings and Cost-Effectiveness Analysis for Low-Voltage Dry-Type Transformers***.

Nellie Leap led this presentation. Using the overhead projector, she touched on the following major topics:

- History: in 1997, Oakridge National Laboratories published a report titled "Analysis of NEMA Energy Efficiency Standards for Distribution Transformers," which assessed suggested efficiency levels for these devices.
- Congress established NEMA TP-1 as the minimum efficiency standard via the Environmental Policy Act of 2005. As of January 1, all transformers manufactured in this country must meet the NEMA TP-1 standard.
- BPA would like to offer incentives under its commercial and industrial programs to encourage the replacement of older transformers with NEMA TP-1 transformers before they fail, for energy efficiency reasons.
- There are at least 770,000 transformers in the Northwest region, average size 80 kVA, average number of homes served 3.
- Application: to step down higher voltages (600 volts and below) to house voltages.
- Rebate calculation for commercial and industrial transformers, and total resource calculator
- Load loss calculations vs. nameplate capacity
- Winding losses
- One question: what's the appropriate cost and incentive for early replacement?
- The most common transformers are 30 kVA, 45 kVA and 75 kVA.
- Benefit-cost ratios (table)
- Conclusion: if we don't offer this type of incentive for early replacement, we will be wasting not only the recommended savings per year for five years, but when the transformer fails, it will be replaced by an off-the-shelf spare, which may be below TP-1 efficiency.

Eckman noted that there are many custom transformer companies out there; if we tell them what to build, they will build it, he said. We can put the incentive out there and let the customers decide whether or not to upgrade. It's pretty obvious, however, that the difference between the baseline and TP-1 isn't that great, so we're going to have to do better than TP-1 to make this pencil out.

Why would we offer an incentive to get customers to install the baseline transformer – why should we pay for that? Baylon asked. Because we're talking about early replacement, Leap replied. I'm having a hard time believing that the old-style transformers are just sitting there on the shelf, particularly lower-voltage transformers, Baylon said. Most of these low-voltage transformers are customer-owned, Eckman replied. However, it might be a good idea to contact some of the large electrical supply houses in Portland and Seattle to find out exactly what they have in stock, Baylon said. We'll see what kind of material stock they have on the shelf, and assess how many months that supply is likely to last, Eckman said. And at that point, we will also need to assess Types II, III and V to see what kind of incentives we should be offering for their replacement, another participant said.

After a few minutes of further discussion, Leap agreed to call the electrical suppliers, such as Platt and North Coast, to get a sense of their stock in hand for low-voltage transformers. Jim Williams also indicated that he would make some calls to companies that supply transformers to the industrial firms check on the size of their inventory of non-TP1 compliant models. No RTF decision was made on this issue at today's meeting. Jim and Nelly agreed to report back at the next RTF meeting.

7. ***Next RTF Meeting Date***.

The next meeting of the Regional Technical Forum was set for Tuesday, April 10.
Meeting summary prepared by Jeff Kuechle, NWPPCC contractor.

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