Repeatability of Whole-Building Airtightness Measurements: Midrise Residential Case Study

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AIVC Airtightness Workshop 2013

Acknowledgements

- Gary Nelson and Terry Brennan
- Mark Faultersack, MG&E
- Peter Burns and Paul Morin of Energy Conservatory
- Dave Schwalbe

Motivation for this work

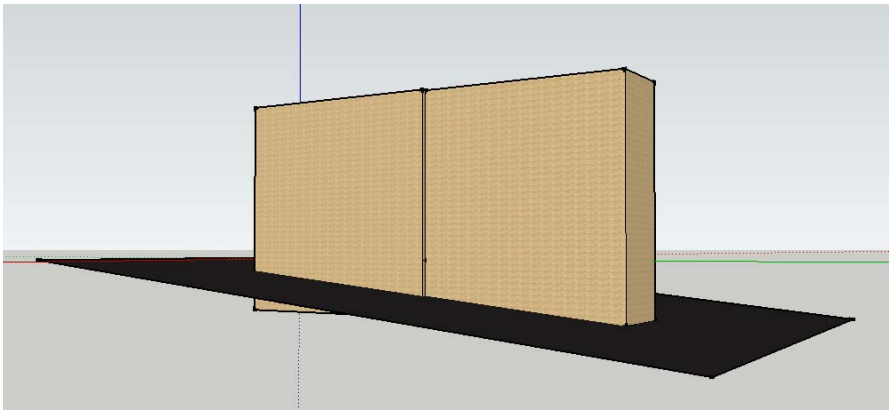
- Originally in support of ASHRAE 1478-RP.
- Testing procedures appeared to be producing repeatable data
  - Narrow confidence intervals on CFM75
  - R-squared > .99
  - A few repeated tests agree well with one another
- HOWEVER…
  - Only a small number of repeats have been done
  - Not much cold weather repeat testing
  - What about more wind or cold and large/tall buildings?

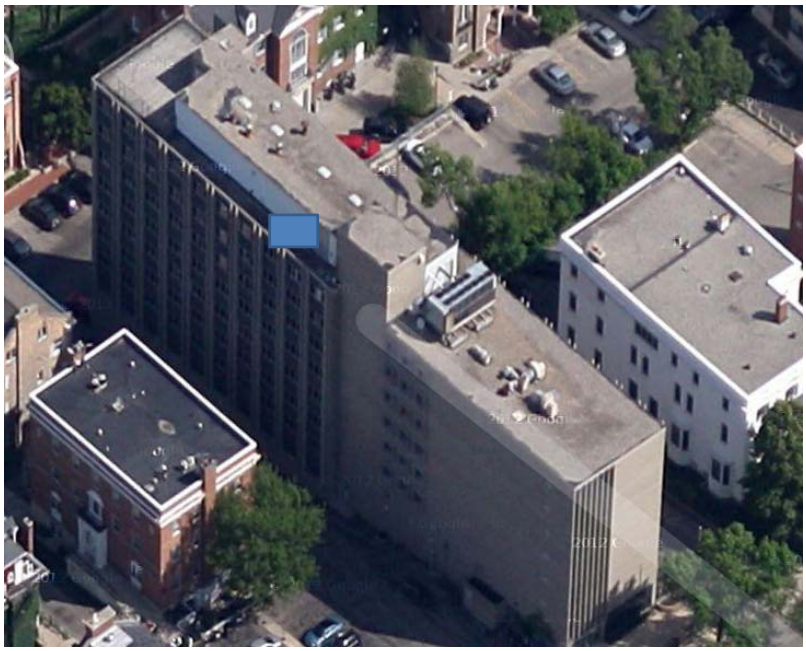
Key Questions

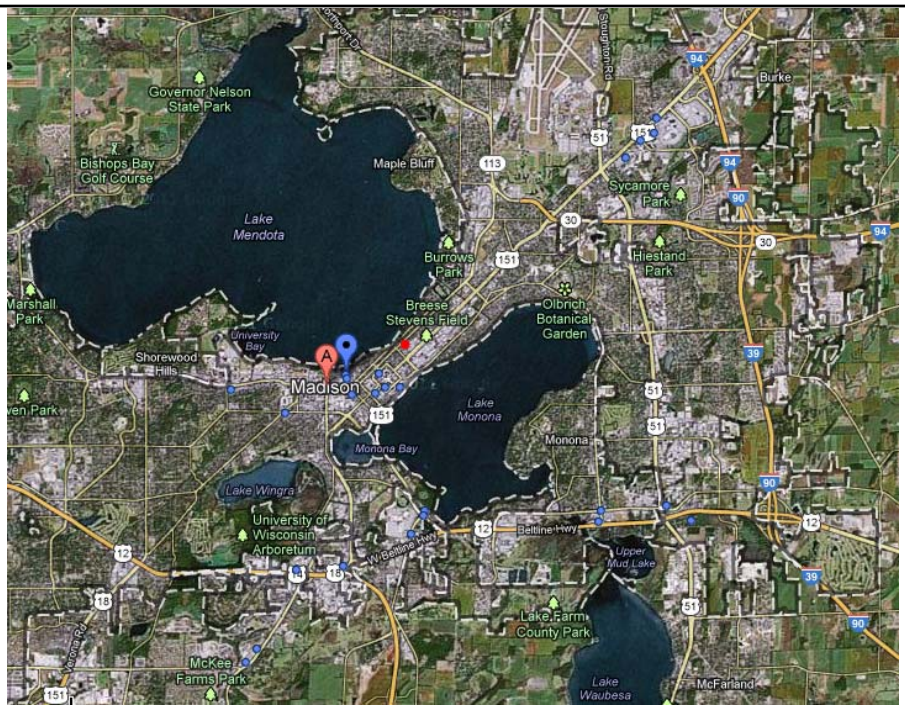
- How repeatable are these test results?
- Which is more repeatable: Single point testing or multi point?
- Does a combination of pressurization and depressurization improve repeatability?
- How well do the statistics work at predicting actual repeatability?

(NOT CONSIDERED: REPRODUCIBILITY – different test personnel and different measurement equipment)

84000 sq. ft. (7800 m2) total envelope
1,000,000 cu. ft. (28,000 m3) volume

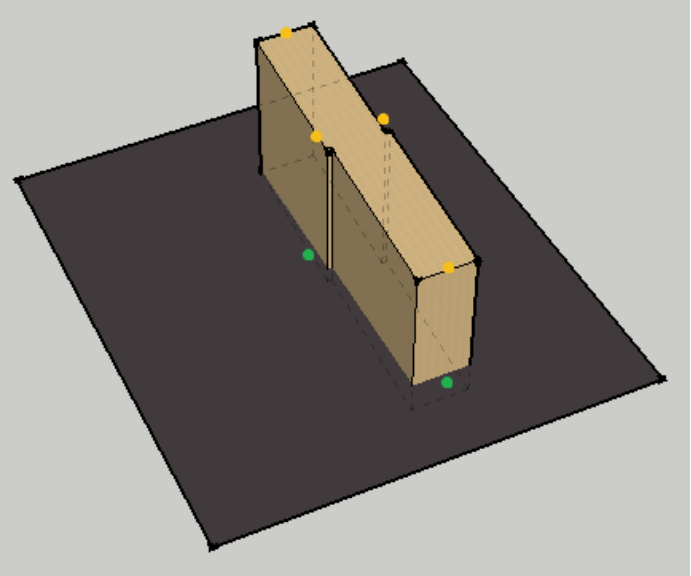






4 Fans installed (2 locations)

8 Exterior Pressure Measurements



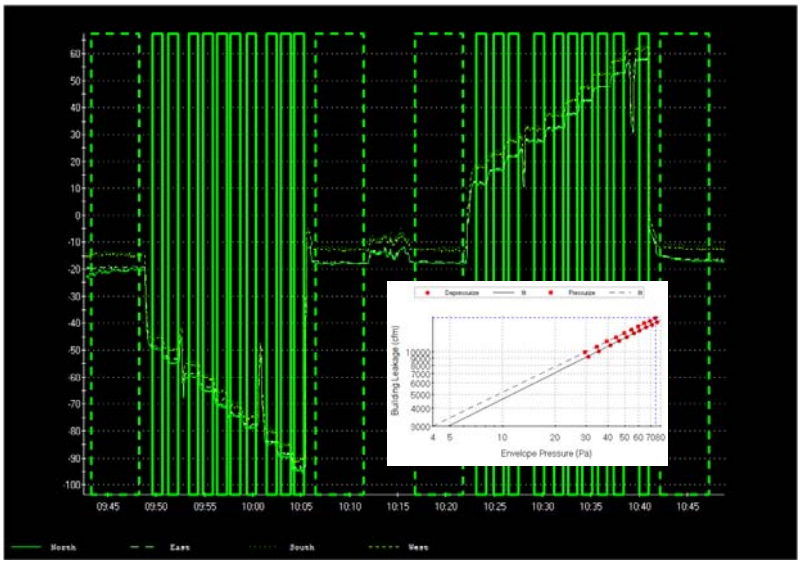
Building Preparation

- Building was tested in two test phases: June and November
- June configuration was replicated in November (we think)
- Building was prepared once for each test phase and left in test condition during the week

Multipoint Sequence

- Depressurization
  - 5 min pre baseline
  - -30 to -75 induced, 1 min each
  - 5 min post baseline
- Pressurization
  - 5 min pre baseline
  - +30 to +75, 1 min each
  - 5 min post baseline

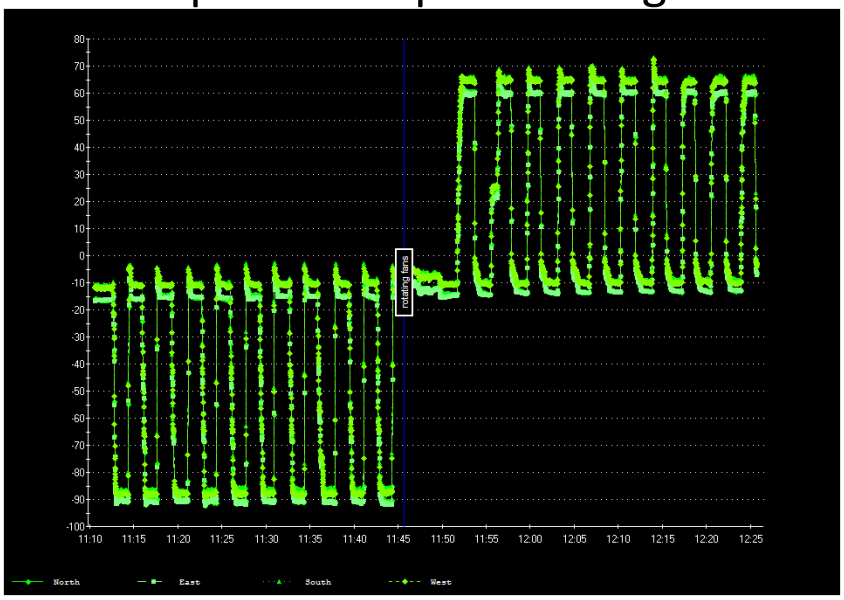
Multipoint Test Sequence



Single Point Sequence

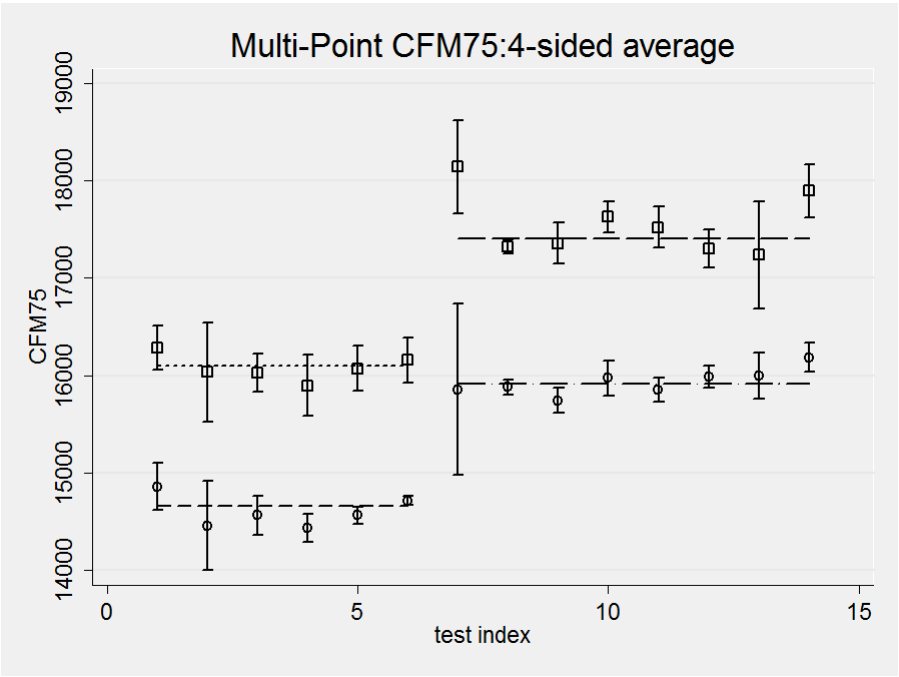
- Depressurization (repeat x 10)
  - 1 minute baseline
  - 1 minute induced -75
- Pressurization (repeat x 10)
  - 1 minute baseline
  - 1 minute induced +75

Test Sequence: Repeated Single Point



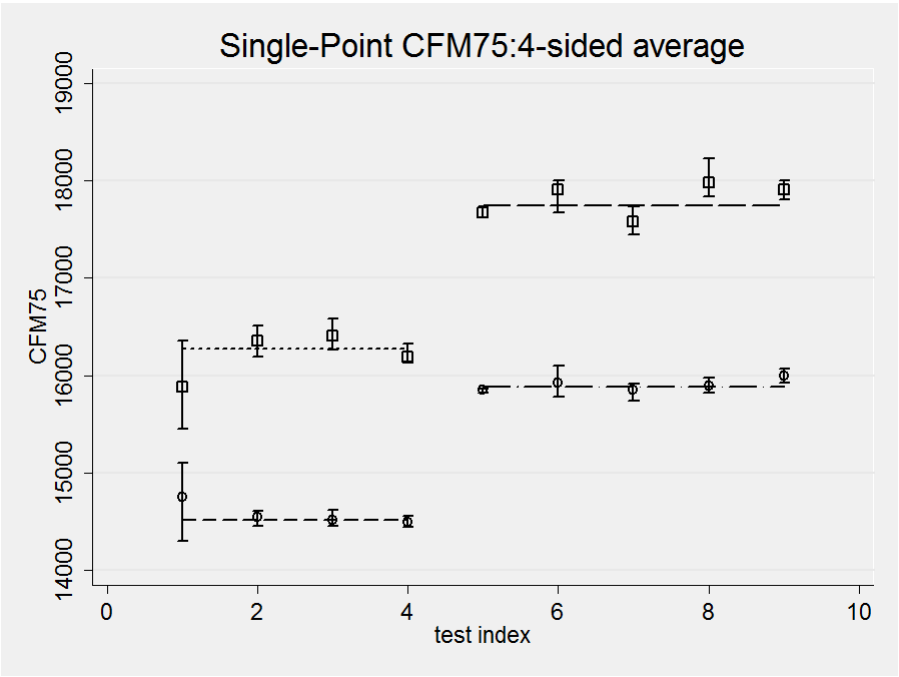
Analysis of Repeated SP Test

- 75 Pa induced pressure is not exactly achieved for each individual fan on period
- n=0.6 used to adjust each measured flow to a predicted Q75 value
- Results are generated from the 10 independent Q75 estimates
  - Overall result given by the simple average Q75
  - Precision estimated from the 10 readings at 95% confidence level



What do we see?

- Press > Depress (about 10%)
- Shift occurred between June and November
- Test index 7 is outlier (can't tell just from data)
- Error bars about 2x too small
- No pronounced cancellation of errors (D vs P)
- Short term precision great, long term poor



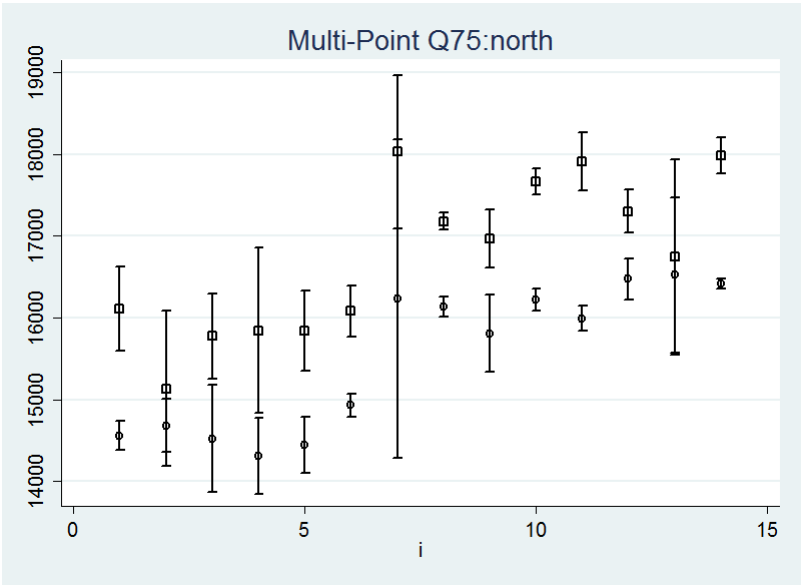
What do we see?

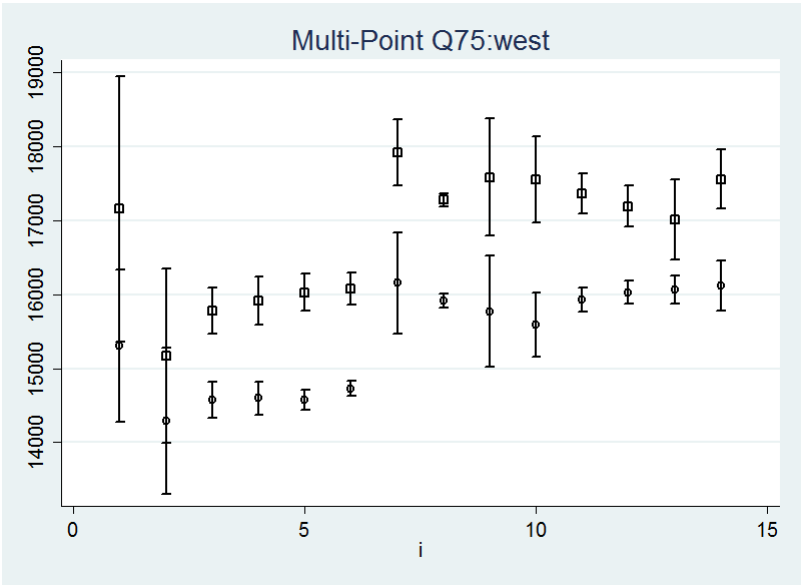
- Tightness results agree with multipoint tests
- Excellent precision (estimated and actual)
- Error bars about the right size
- Again no strong precision benefit from D&P

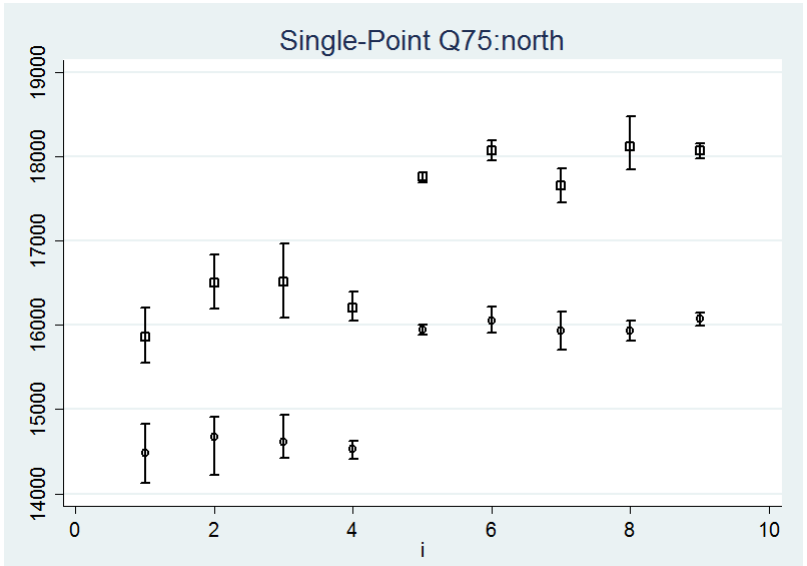
Conclusions

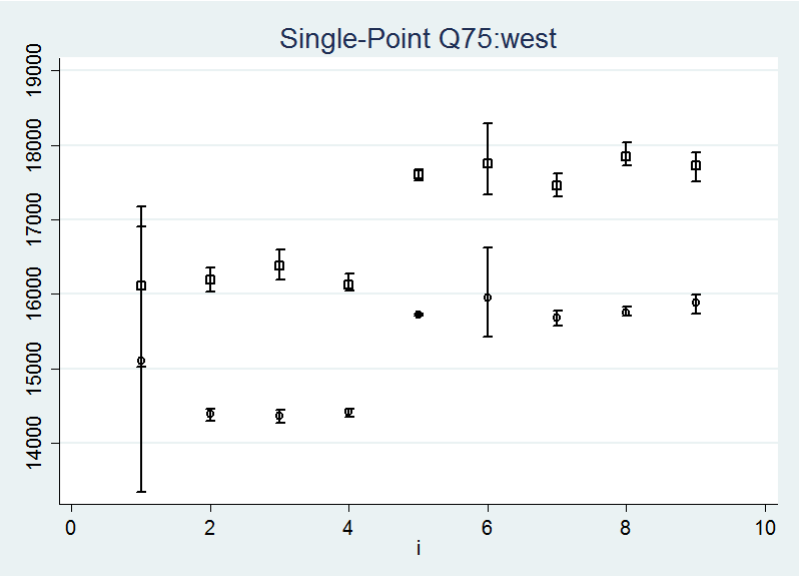
- Both single point and multipoint tests had good precision within each test phase…
- +10% change from June to November
- No clear bias due to wind
- Single point precision was better than MP
  - same amount of time per test
- Precision error estimates for multi-point tests are too small, single point precision error estimates worked well.

Thanks for Listening


Multi-Point Q75:north
14000
15000
16000
17000
18000
19000
0
5
10
15
i


Multi-Point Q75:west
14000
15000
16000
17000
18000
19000
0
5
10
15
i


Single-Point Q75:north
14000
15000
16000
17000
18000
19000
0
2
4
6
8
10
i


Single-Point Q75:west
14000
15000
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