

# Infiltration Testing In Multifamily Buildings

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# Goals Of This Workshop

- You CAN test infiltration in large MFB's
- Share some information on how we've been doing it
- There are some very important planning considerations
- Hardware and set-up still require improvisation
- Communication with staff on site is critical
- Wisconsin work is on-going – before-after analysis is in progress

# Issues We WON'T Discuss

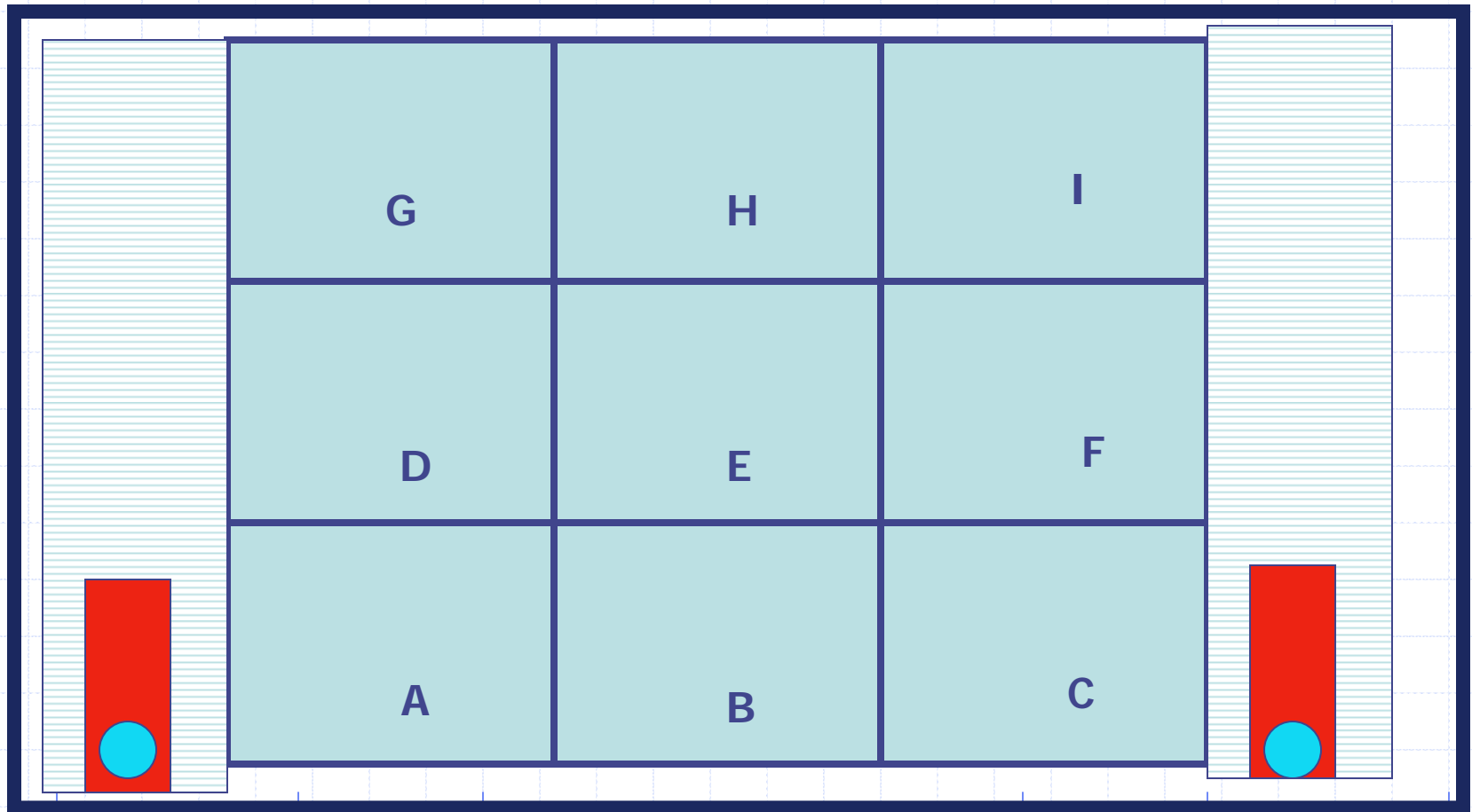
- Why Test?
  - Effects of air sealing known, but not quantified
  - Small shell-volume ratio implies infiltration not important
  - Stack effect implies air infiltration is huge driver
- Multi-point vs single-point test
- Test whole building or individual units
  - “Common sense” says residence is the unit, not the entire building – test unit
  - Air sealing shell has good results—test the shell

# Testing The Entire Shell

- You get one chance--have enough capacity
- Close EVERY exterior window
- Open EVERY interior door (except utility room)
- Manage air handlers (turn off, cap, etc.)
- At least one security person on each floor
- Co-ordinate all doors
- Multi-point test - complex but necessary
- Minneapolis Doors interact!

# Whole Building Test Methods

- Multi-point test is difficult, *(but very necessary, IMHO.)*
- Testing at pressures of 90+ Pa reduces wind effects (if you have capacity!)



# Infiltec G-54: 60,000 CFM, 25 HP unit



# Multiple Minneapolis Doors

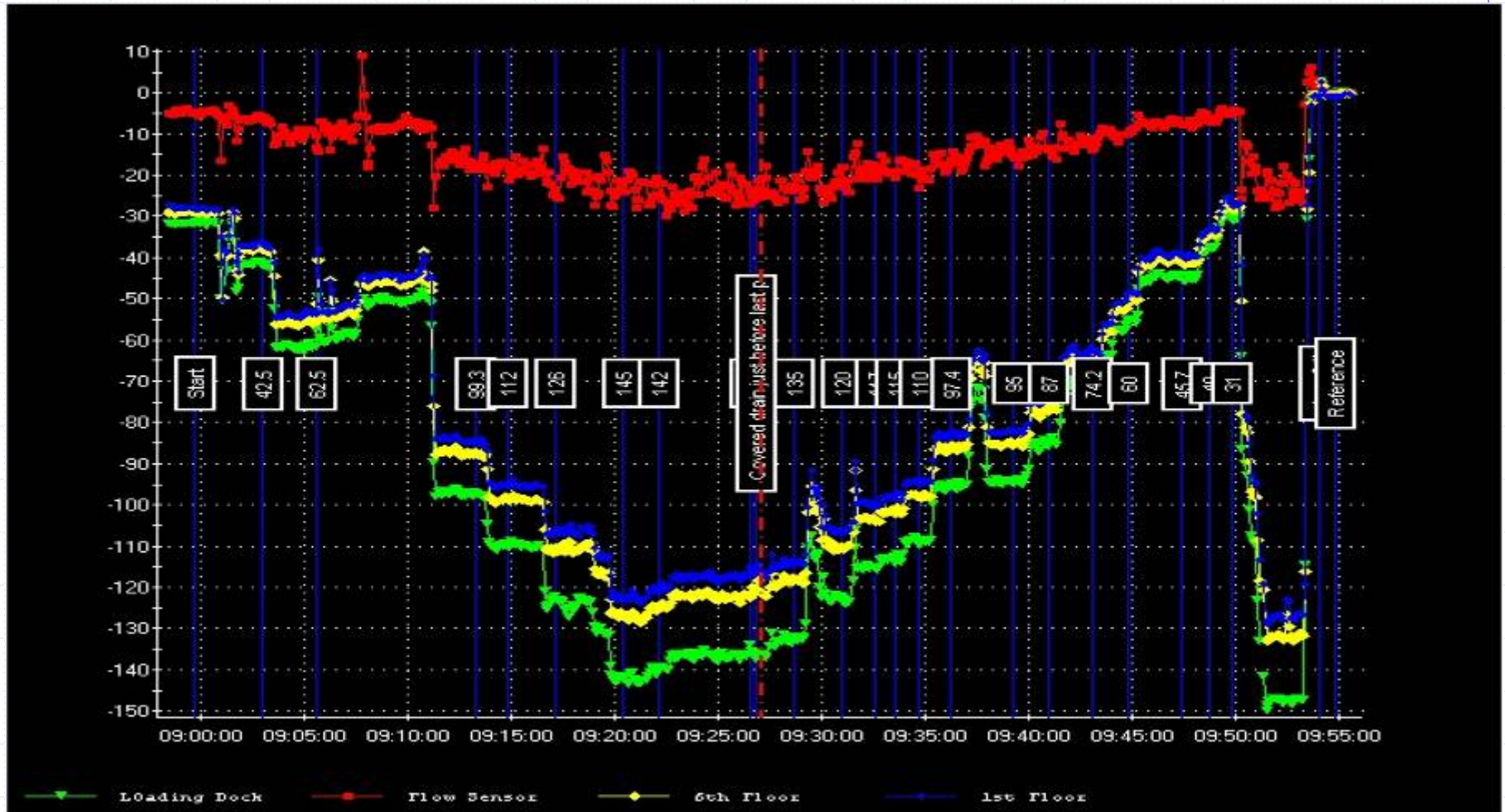


- Easier to distribute through building
- Smaller localized flows
- More manpower
- Communications and data issues

# Using the G-54

- Benefits
  - Single unit; no communication issues
- Problems
  - MFB's have small "plenums"
    - Pressure may not be uniform to +/- 10%
    - Need to keep air paths open
    - Have 2 Ft<sup>2</sup> of opening for every 1,000 CFM
    - Stairwells should be even larger
  - MFB's often don't have suitable door

# Pressure Responses Not Uniform



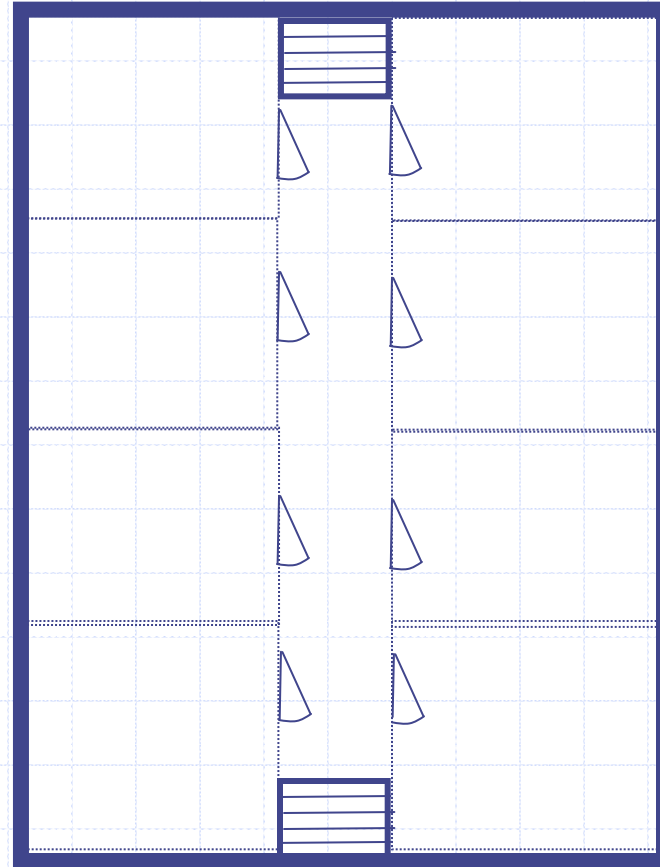
4-story office building with G-54 in loading dock

# Multiple Minneapolis/RetroTec Fans



- Note: Three fans develop a LOT of force; secure the frame!

# 2905 W Wis. Experimental Site



# Experimental Site Tests

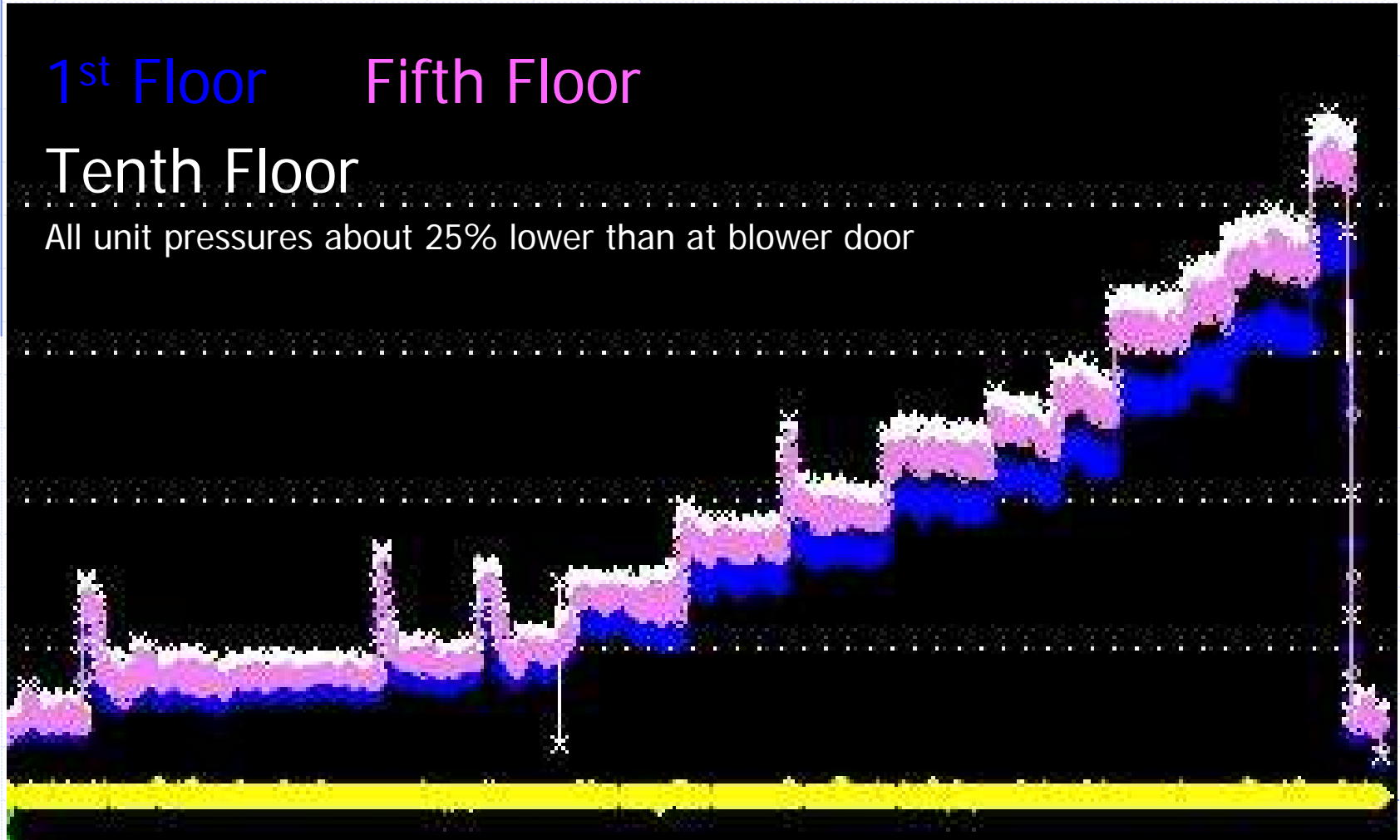
- G-54 test from parking garage
  - Unable to test leakage across garage/residence surface, a crucial surface
- Seven Minneapolis blower doors
  - “APT-guided” tests
    - Two fans in elevator penthouse
    - Three fans in front door
    - Single fans in two back first-floor door
  - De-pressurize and pressurize modes

# 2905 W Wis. Single (G 54) Blower Door – Non-uniform Response

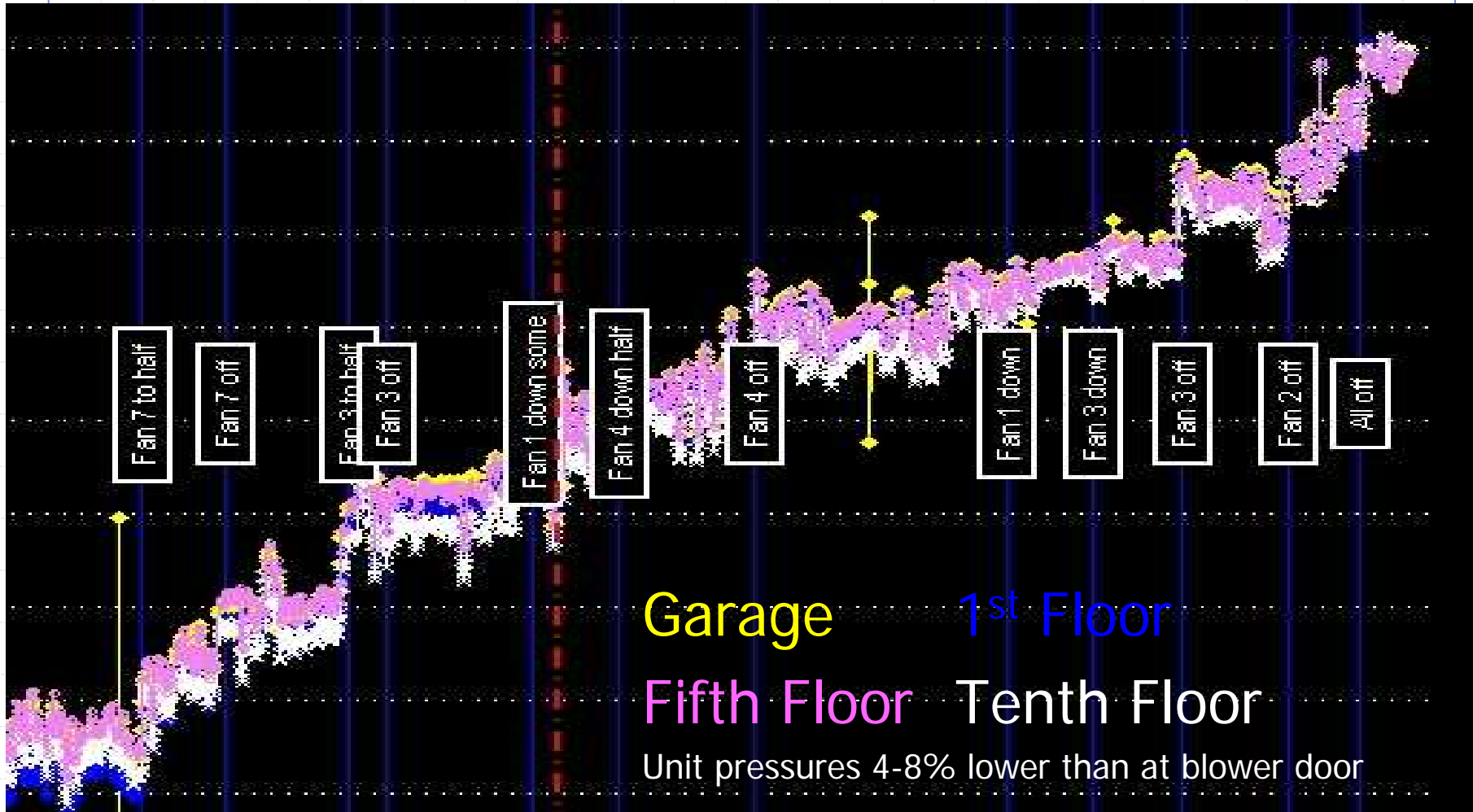
1<sup>st</sup> Floor      Fifth Floor

Tenth Floor

All unit pressures about 25% lower than at blower door



# Seven Minneapolis Doors—Uniform Response



# So – How Do You Do This?

- Planning
  - Capacity; 0.75 to 2 CFM50/Ft<sup>2</sup> of envelope
  - Location of doors to attain clean air flows
  - Prep of ventilation system
    - What is “winter operating condition”?
  - Operators, security, set-up and tear-down
- Communication
  - Owners, managers, residents
  - Staff that knows HVAC setup
- Security
  - Assure owner/manager is prepared

# Set-up and Scheduling

- Managers need lots of information
  - What, when, why, how
- Residents need limited information
- Make sure managers commit staff
- Division of responsibility
  - Management opens & secures building
  - Management initiates any emergency response

# Tools and Supplies

- Lots and lots of wedges & tubing/tees
- Set-up tools and supplies
  - Drill driver, door hardware tools, ladder
  - EPS foam, wire, line to secure fan hardware
  - Poly sheeting, tape to seal intentional openings
  - Heavy power cords, outlet adapters, light socket adapters, batteries
- Blower Doors/DG-700's/APT & laptop
- Two-way radios
  - Note that three fans make a lot of noise



# Personnel

## Building

- One person on each hall/level
- One person at main entrance
- One person at all other heavily-used entries
- **Blower Doors/DG-700**
  - One operator for each location
  - One person monitoring APT, calling marks, recording data
  - ONE PERSON checks all gauge settings

# So – How Do You Do This?

- Real-time APT Pressure Monitoring
  - Multiple sample locations; low and high, windward and leeward
  - Watch gusts
  - “Mark” readings when APT shows stable pressures
- Use common reference if possible
- Spot-check data while on site
  - Excel spreadsheet for quick & dirty data check

# APT Pressure Monitoring



# So – How Do You Do This?

- Start up slowly and get doors in synch
  - Read baselines
  - Start every door at low power;  $< 10$  Pa
  - Start stubborn/windward doors with cover on
- Ramp up doors in tandem
- Use HIGH pressures
  - Have capacity to make 100 Pa
  - We have taken areas of buildings to -140 Pa (don't try this at home...)

# Lessons Learned – Eight Buildings, 15-20 Tests

- Accurate, precise testing is possible
  - Results with standard deviation  $< 1\%$ ,  $R^2$  of 0.97 on windy day, 0.99 on good day
  - Test 50 units in half a day
- Communications are constant problem
  - Before and during testing
- Be Prepared!
  - You get one shot
  - Have tested in 25 MPH winds, day after an industrial explosion, in building without doors

# More Lessons Learned

- APT units don't like to get cold
- A happy crew is an efficient crew (*and vice versa*)
  - Be VERY clear what is happening, who does what
  - Assure food, water, bathroom access