What does a 2-Day Minimum Sample Duration Really Mean?

Presented by: Shawn G Price

October 27, 2025

Measurement Protocol History - 1986

- EPA publishes the *Interim Indoor Radon and Radon Decay Product Measurement Protocols*
- Standardized House Conditions, aka “closed-house conditions”
- Where and when the radon concentrations are likely to be stable
- Continuous radon monitors, charcoal cans, alpha tracks, grab samples
- RDP methods: CWLM, RPISU, grab samples
- Challenges: nonstandard conditions, house conditions, weather/seasons
- QA/QC: calibrations, spikes, “blind calibrations, blanks, duplicates

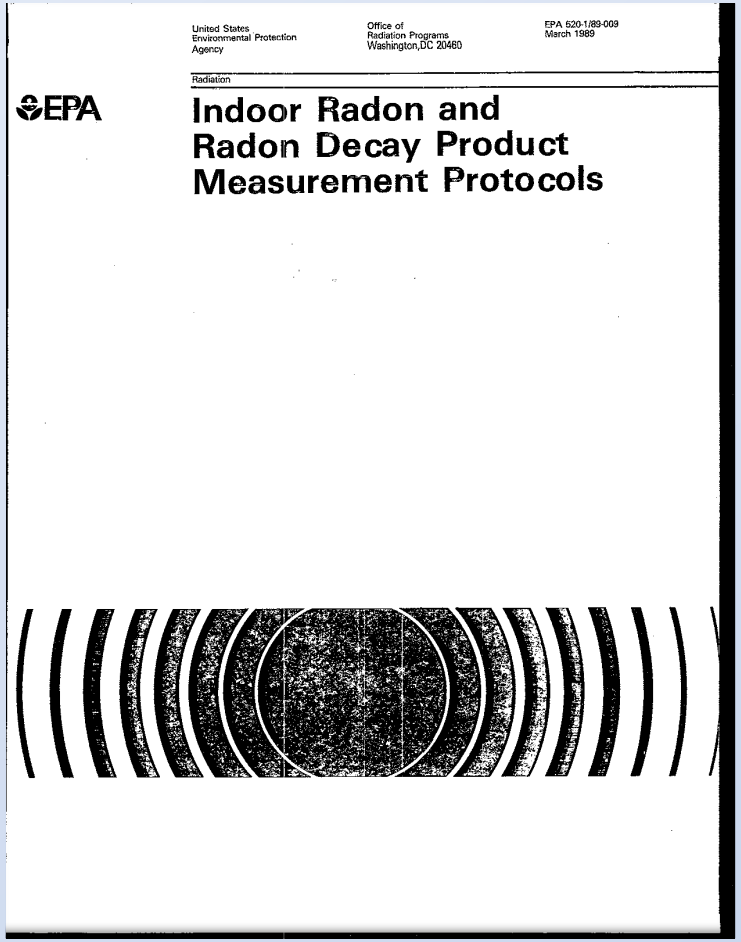
1986 Interim Protocols

- Test Durations
- Continuous radon monitors – record hourly, not less than 24 hours
- Charcoal canisters – 3-7 days
- Alpha tracks – 12 months preferred, 30 day minimums were common

- Industry started evolving with new equipment and methods being developed
- Magnitude of the radon issue still being assessed

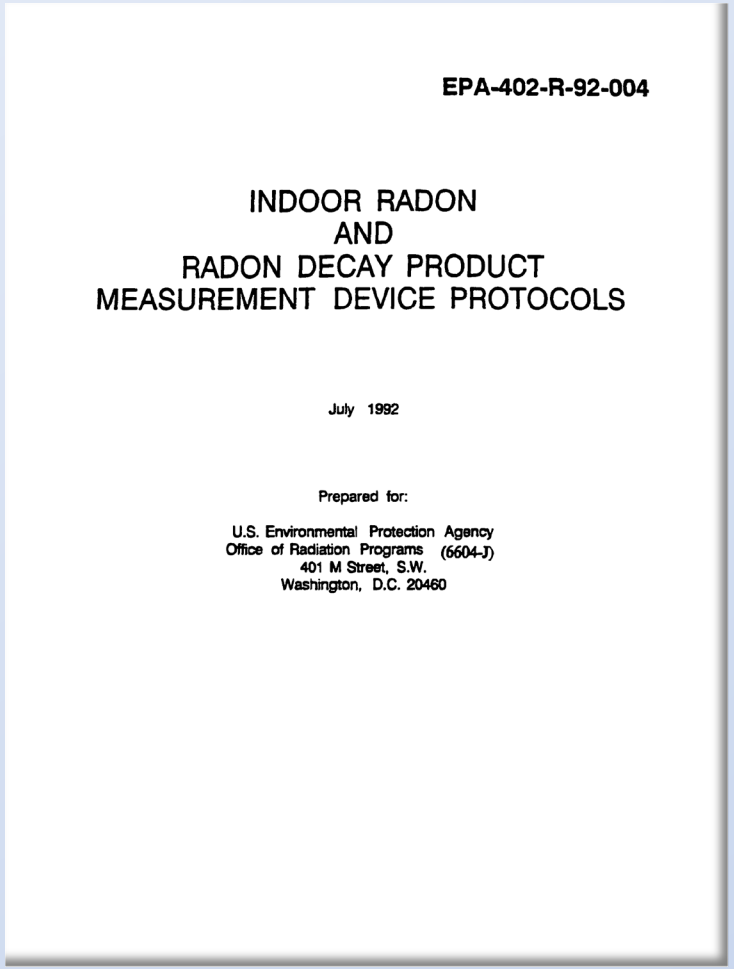
1989 – no longer Interim

- 2-step procedure recommended: short-term followed by long-term
- Electrets, Liquid Scintillation, various grab methods added
- Screening measurements: closed building conditions from one day to three months.
- If testing for one to several days, test in 24-hour increments
- Several grab samples taken over a 24-hour period can be averaged into a one-day test



1992 – EPA Device Protocols

- Replaced 1989 Protocol- new information, procedures, new devices.
- Guidance documents were being developed
  - Citizen's Guide,
  - Homes Protocol,
  - Schools,
  - Real Estate
- Significant change – all devices to be deployed for minimum of 48 contiguous hours.
  - Exceptions: research, mitigation diagnostics



EPA-402-R-92-004

INDOOR RADON
AND
RADON DECAY PRODUCT
MEASUREMENT DEVICE PROTOCOLS

July 1992

Prepared for:

U.S. Environmental Protection Agency
Office of Radiation Programs (6604-J)
401 M Street, S.W.
Washington, D.C. 20460

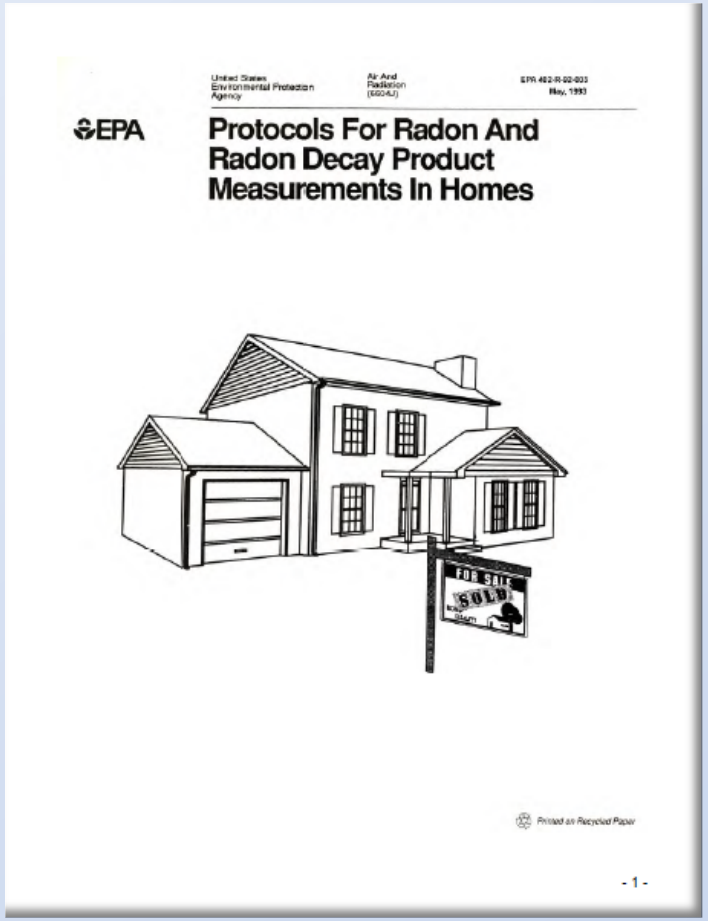
1992 – EPA Device Protocols

- Better consistency & decision making
- Two diurnal cycles was determined to improve measurement quality
- When impossible to terminate tests exactly at 48 hours, a 2-hour grace period was allowed. 46 hours were considered 2-day measurements
- First 4 hours of CRM data could be discarded

- If closed-building not met 12 hours prior to the test – minimum duration is 4 days

1993 – EPA Homes Protocol

- Clarified the Screening/Follow-Up Guidance
  - Minimum test period still 48 hours
- Introduced Real Estate Testing Protocols
  - Sequential & Simultaneous with passive devices – minimum test 48 hours if closed-building 12 hours prior to test
- CRM tests – can test for 60 hours and remove first 12 to account for closed-building (min 58)
- Can remove 4 hours for equilibrium, 44 contiguous hours of data required

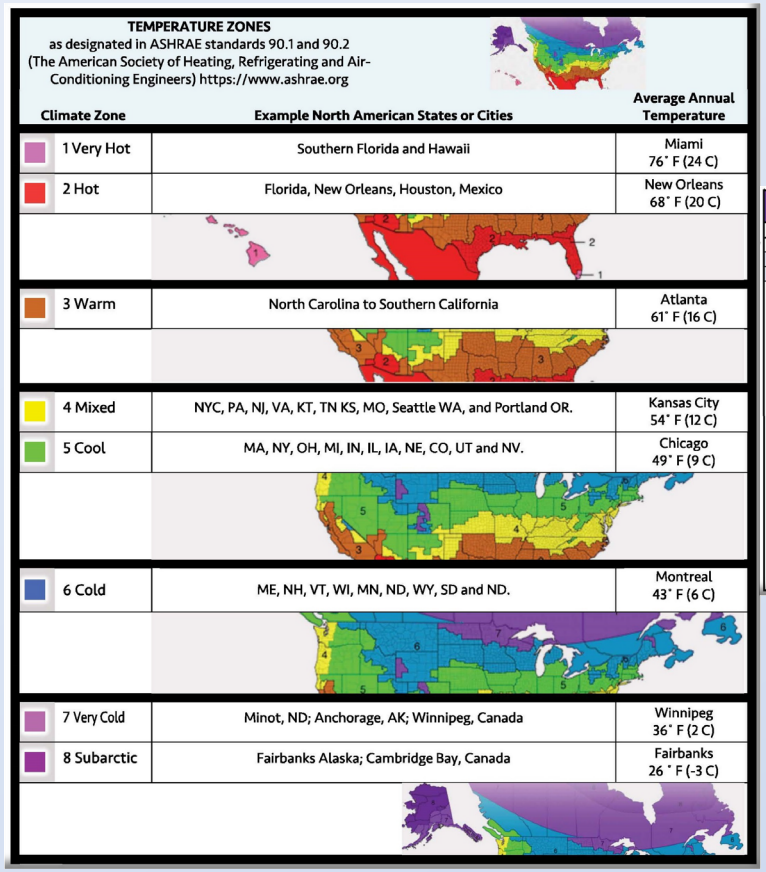


1993/1994 EPA Mitigation Standards

- Post Mitigation testing requirements
- Allow system to run for 24 hours after activation
  - Closed-building upon completion of system
  - Passive devices – minimum of 46 hours
  - Continuous monitors – can be started immediately, remove first 24 hours of data. Minimum total test length 72 hours. *70 might be considered OK (24 + 46)*
- Further testing & retesting recommended to ensure low annual averages

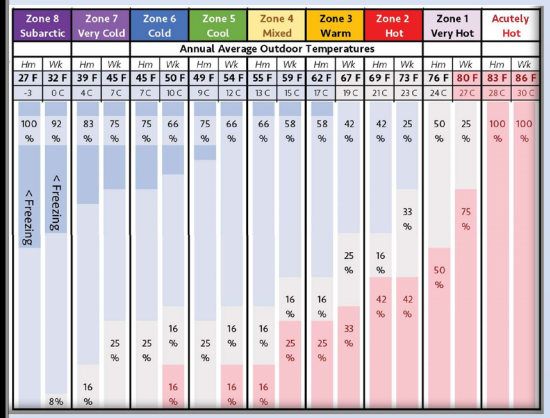
ANSI/AARST MAH & MA-MFLB

- EPA protocol foundation remains
- If 12 hours closed-building not met prior, minimum test = 3 days, passive devices
- More detail in temporary conditions & HVAC systems
- Emphasis on heating/cooling ratios using ASHRAE climate zone maps



TEMPERATURE ZONES
as designated in ASHRAE standards 90.1 and 90.2
(The American Society of Heating, Refrigerating and Air-Conditioning Engineers) https://www.ashrae.org

Climate Zone	Example North American States or Cities	Average Annual Temperature
1 Very Hot	Southern Florida and Hawaii	Miami 76˚ F (24 C)
2 Hot	Florida, New Orleans, Houston, Mexico	New Orleans 68˚ F (20 C)
3 Warm	North Carolina to Southern California	Atlanta 61˚ F (16 C)
4 Mixed	NYC, PA, NJ, VA, KT, TN KS, MO, Seattle WA, and Portland OR.	Kansas City 54˚ F (12 C)
5 Cool	MA, NY, OH, MI, IN, IL, IA, NE, CO, UT and NV.	Chicago 49˚ F (9 C)
6 Cold	ME, NH, VT, WI, MN, ND, WY, SD and ND.	Montreal 43˚ F (6 C)
7 Very Cold	Minot, ND; Anchorage, AK; Winnipeg, Canada	Winnipeg 36˚ F (2 C)
8 Subarctic	Fairbanks Alaska; Cambridge Bay, Canada	Fairbanks 26 ˚ F (-3 C)



Zone 8 Subarctic		Zone 7 Very Cold		Zone 6 Cold		Zone 5 Cool		Zone 4 Mixed		Zone 3 Warm		Zone 2 Hot		Zone 1 Very Hot		Acutely Hot	
Annual Average Outdoor Temperatures																	
Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk
-3	0 C	4 C	7 C	7 C	10 C	9 C	12 C	13 C	15 C	17 C	19 C	21 C	23 C	24 C	27 C	28 C	30 C
100 %	92 %	83 %	75 %	75 %	66 %	75 %	66 %	66 %	58 %	58 %	42 %	42 %	25 %	50 %	25 %	100 %	100 %
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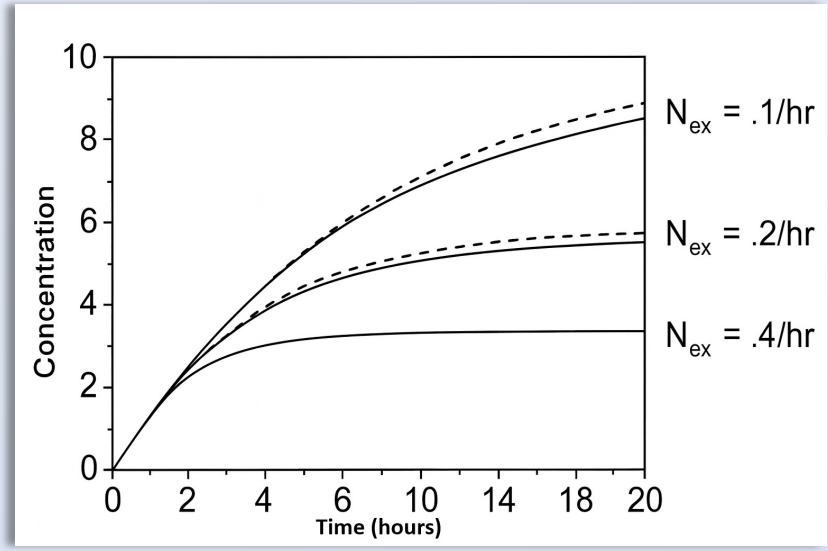
Equilibrium

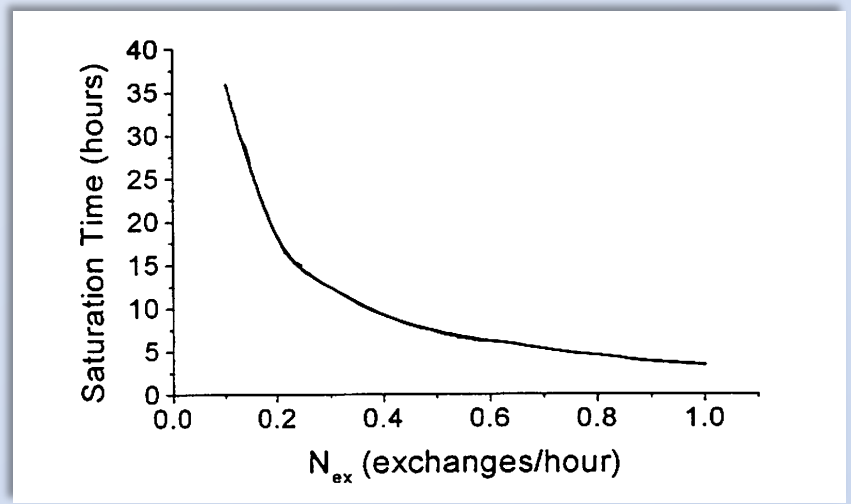
- Dynamic vs Secular
- *Dynamic equilibrium* accounts for the 12 hours that the building needs to be closed prior to a 2- or 3-day test.
- If a CRM is deployed as closed building conditions are initiated, then the first 12 hours can be removed from final average or the device can be put into delay mode to start 12 hours after deployment
- Passive devices should be deployed for 3-4 day* minimums to account for dynamic equilibrium

* 2023 ANSI/AARST = 3 day minimum

Dynamic Equilibrium – is 12 hours enough?

- Sometimes, maybe, it depends… Thanks Bruce! ☺
- ***A New Look at the Twelve Hour Dynamic Equilibrium Protocol,*** J.F. Burkhart and R.E. Camley, AARST/IEA Las Vegas, NV 1999
- If ACH ~0.4, 12 hours is sufficient
- Tight houses may take longer. i.e., 0.1 ACH = 36 hours





*Secular Equilibrium**

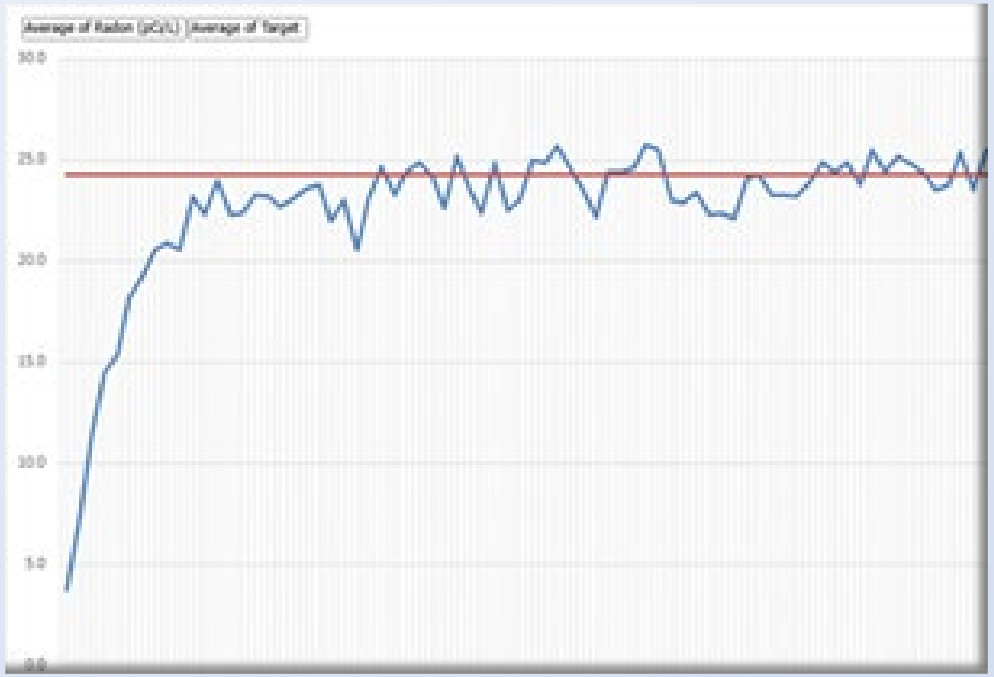
- Secular equilibrium is the ingrowth period that it takes for radon decay products (Po218, Pb214, Bi214, and Po214) to equalize with Rn222. (~4 hours)
- CRMs that count Po218 and Po214 may need first 4 hours of data removed for best accuracy
- Ohio Radon Rules require 48 hours of contiguous data. 52 hours of operation required if removing 4 hours.

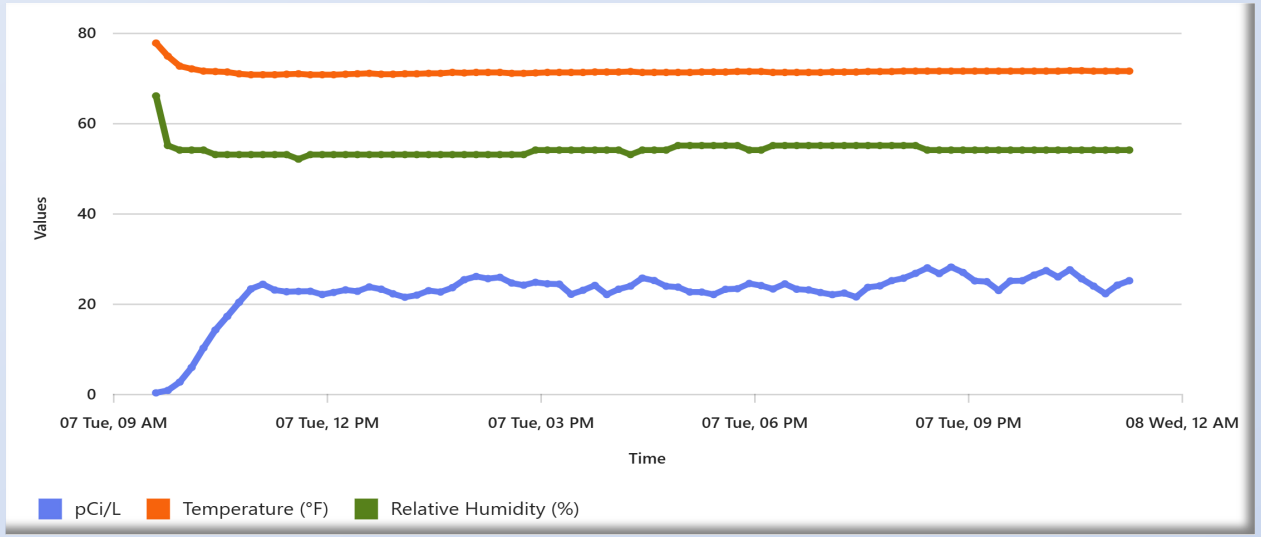
* Ask your manufacturer how this impacts your devices

Type of Radiation	Nuclide	Half-life
	Radon-222	3.825 days
α		
	Polonium-218	3.05 minutes
α		
	Lead-214	26.8 minutes
β		
	Bismuth-214	19.7 minutes
β		
	Polonium-214	0.00015 sec
α		
	Lead-210	22 years

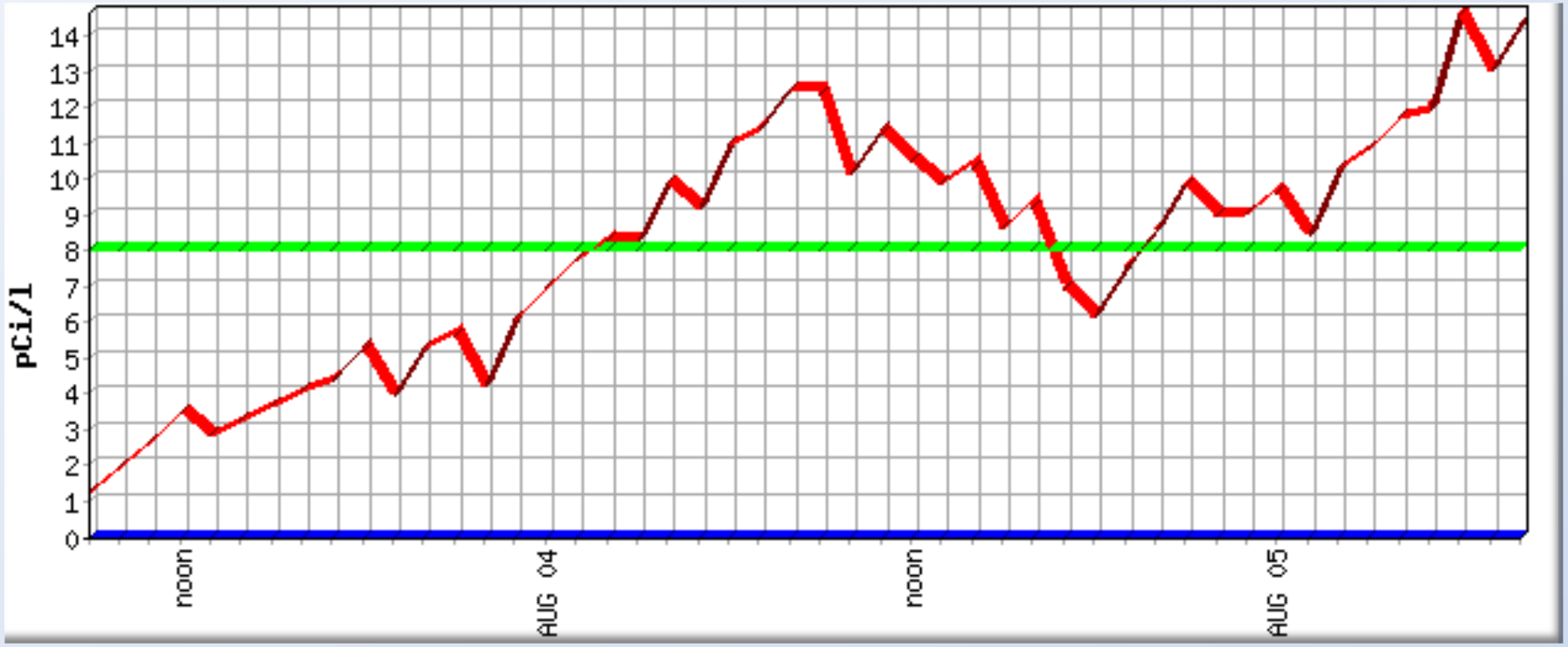
Equilibrium

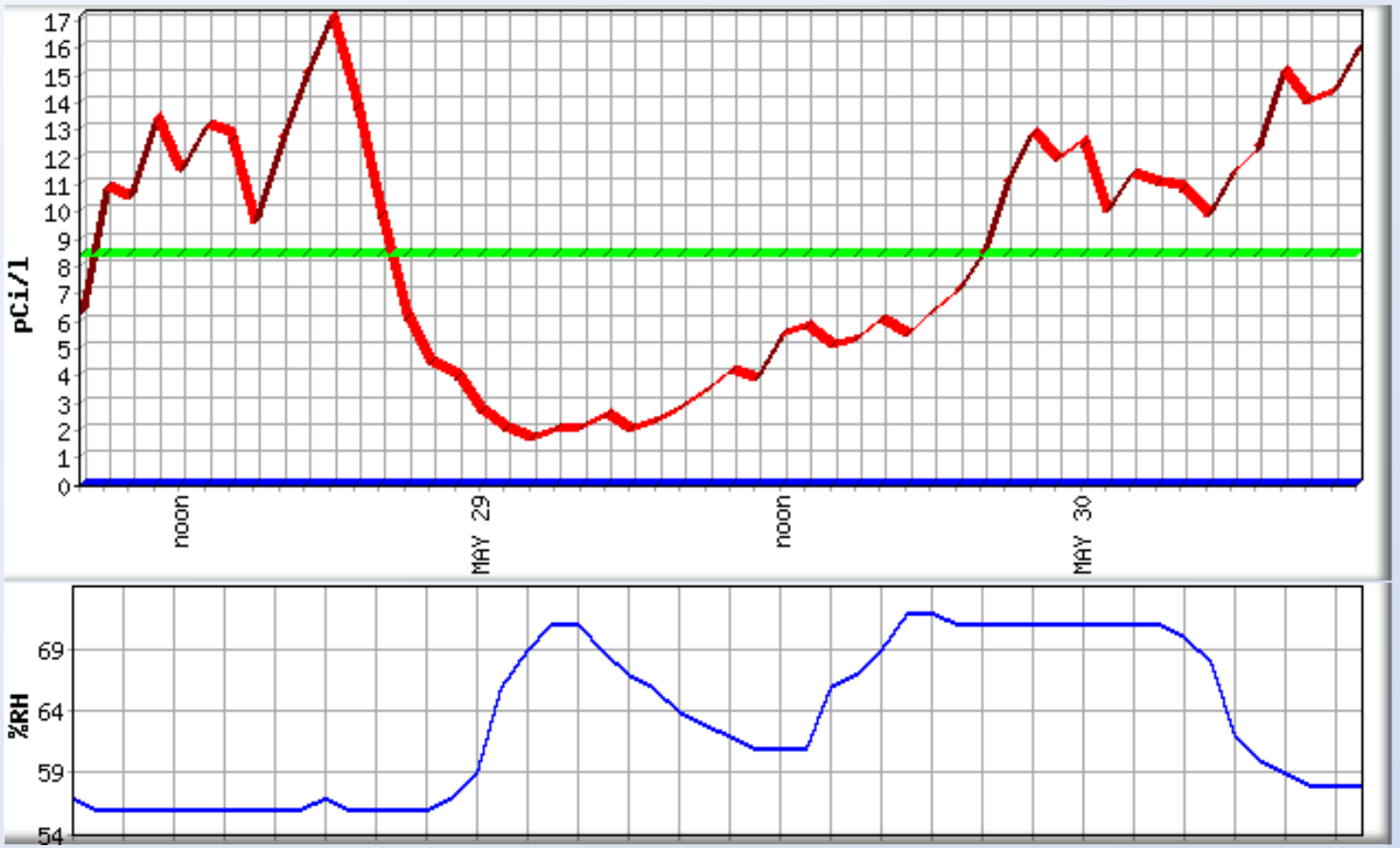
- A device *also* equilibrates with the room air at the beginning of the test.
- Ask your manufacturer how long it should take for your devices to complete the equilibrium cycle.





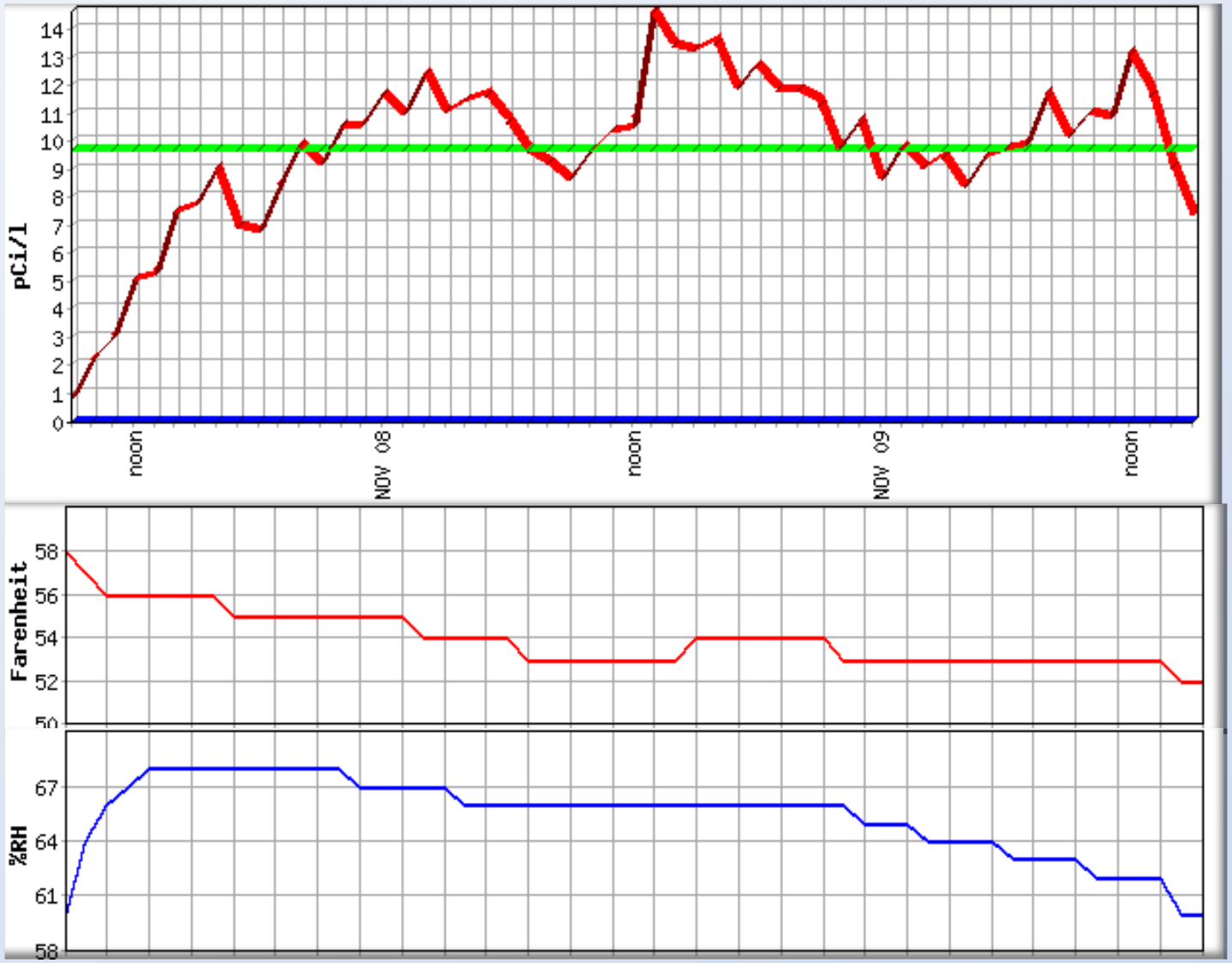
Real Examples – is 48 hours adequate?





Rain & wind direction changed

12 Hours?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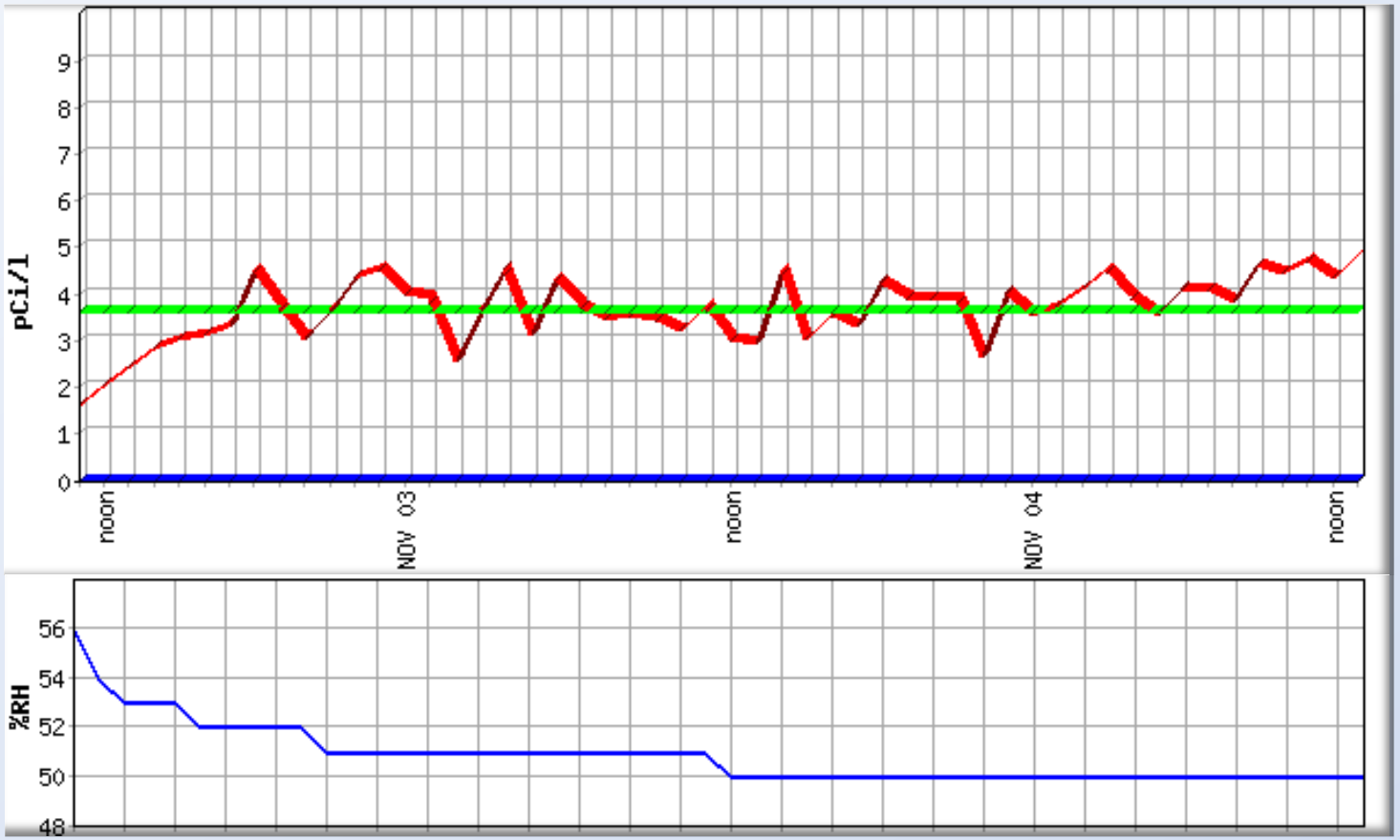
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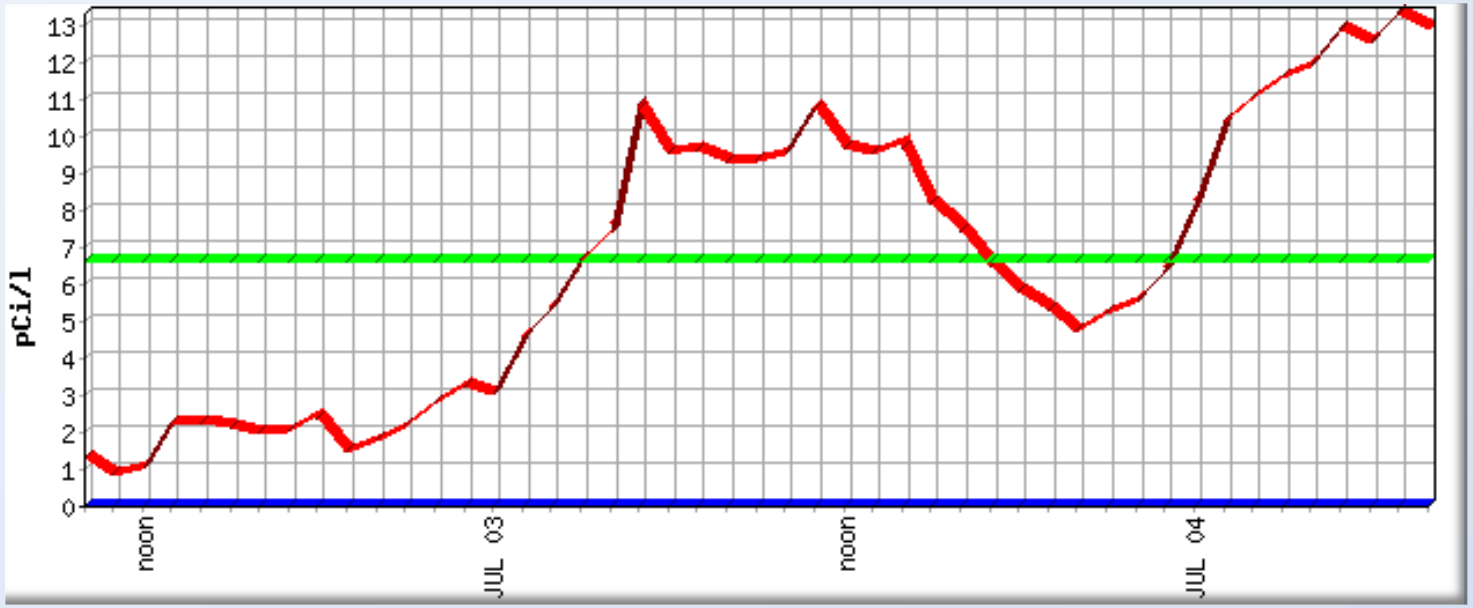
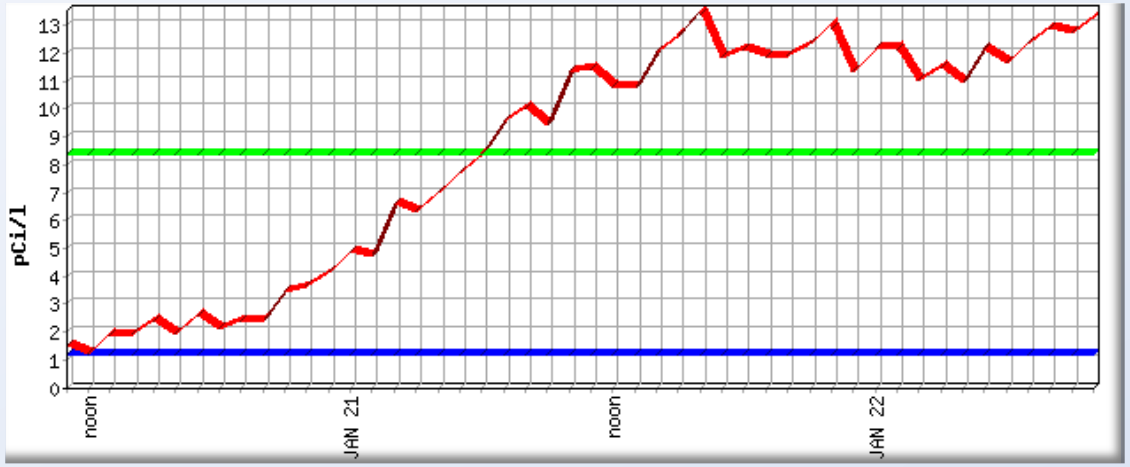
Weather

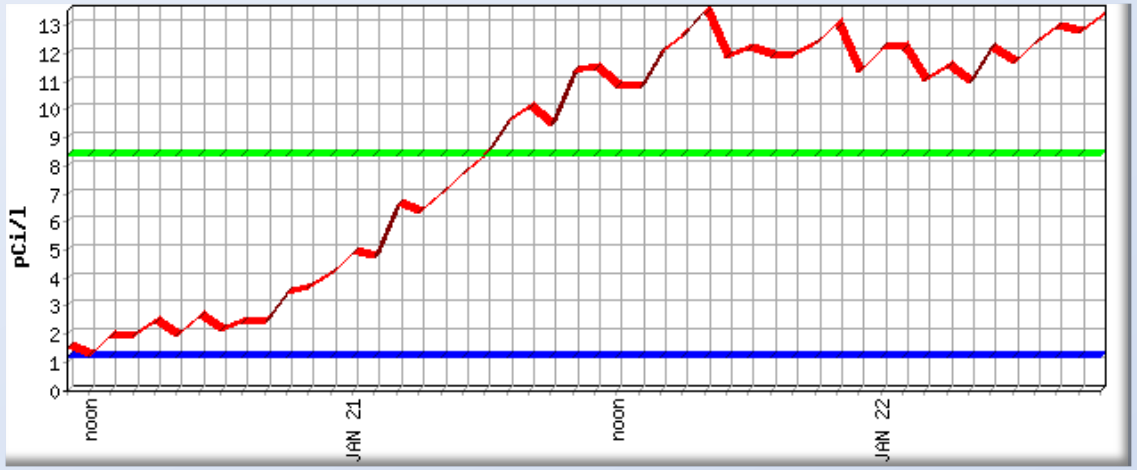
Two New York Homes

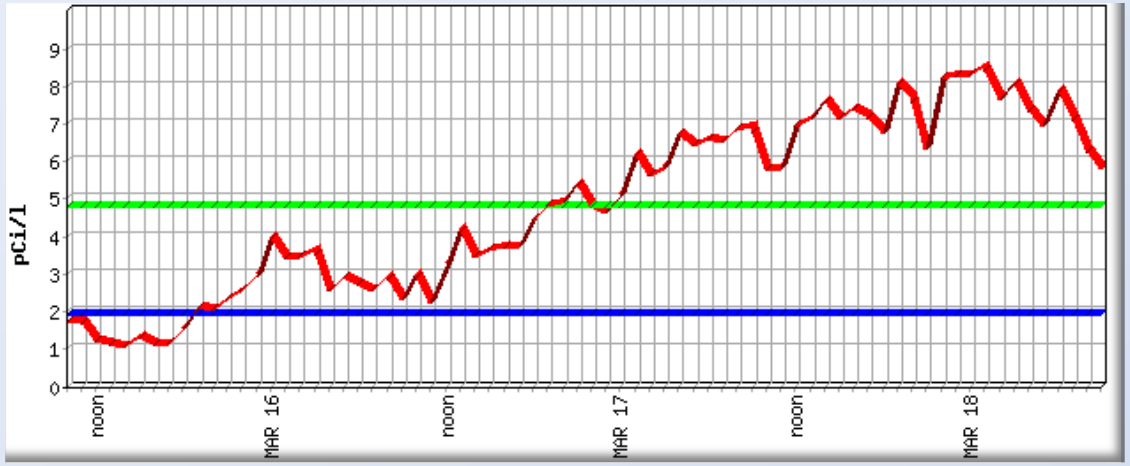
- 90 degrees at start
- Low 60s at end

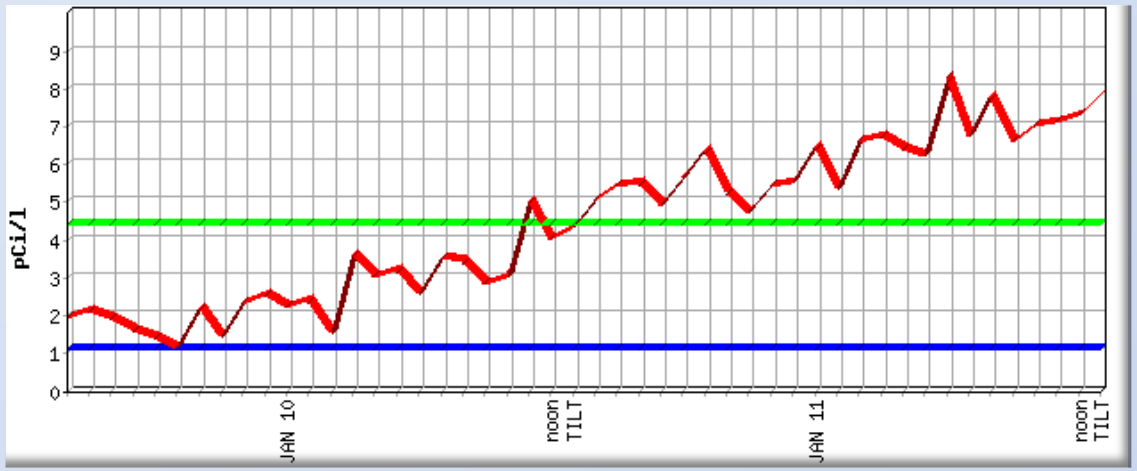


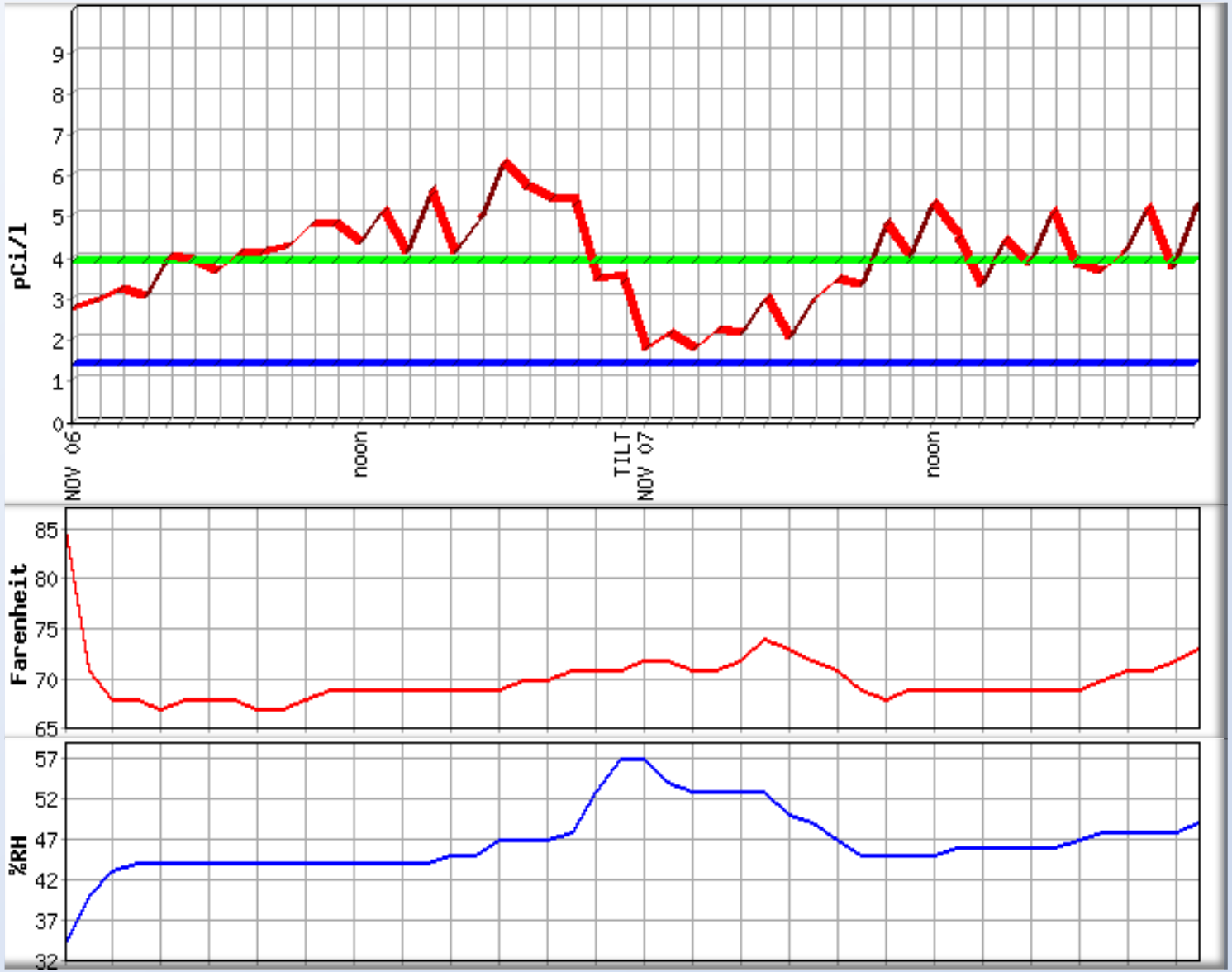
Florida – No 12 hours, Concrete & Low ACH







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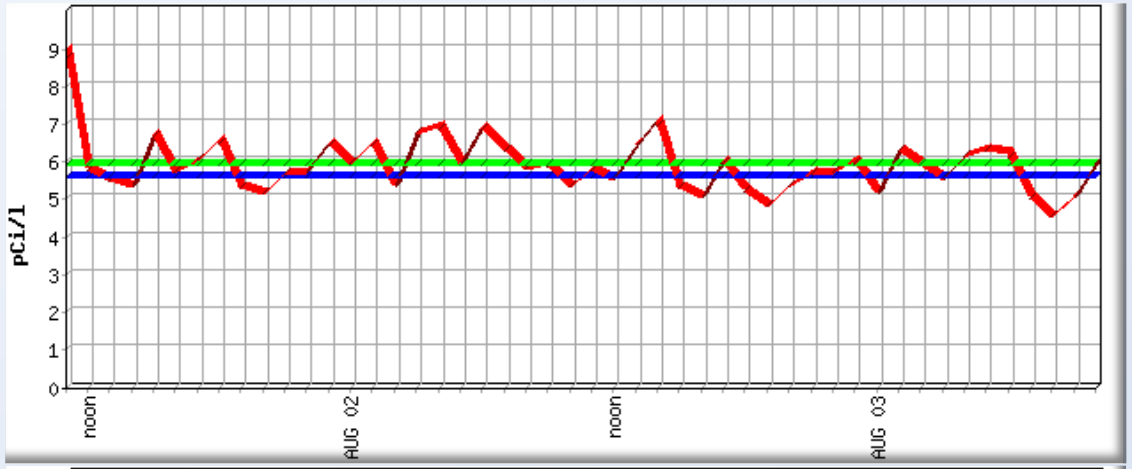
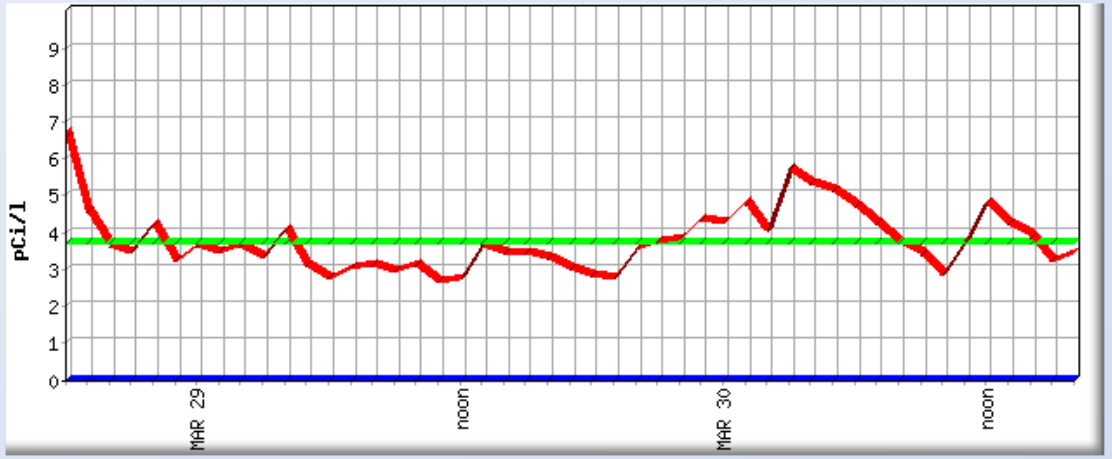
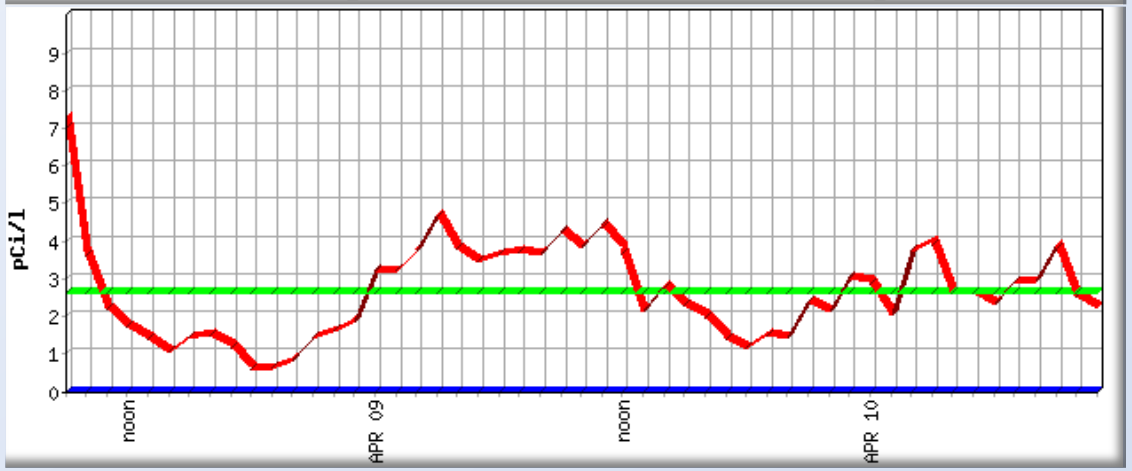
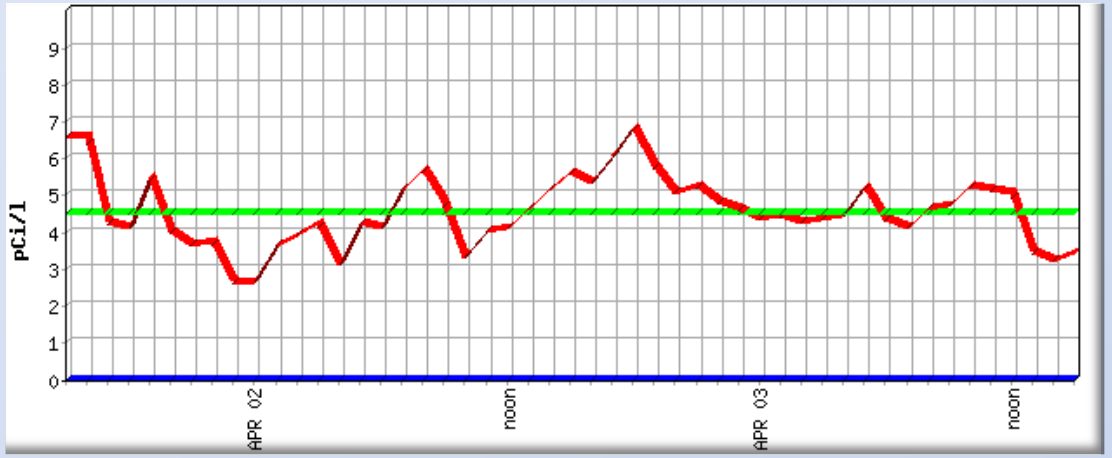
Bringing Radon With You?









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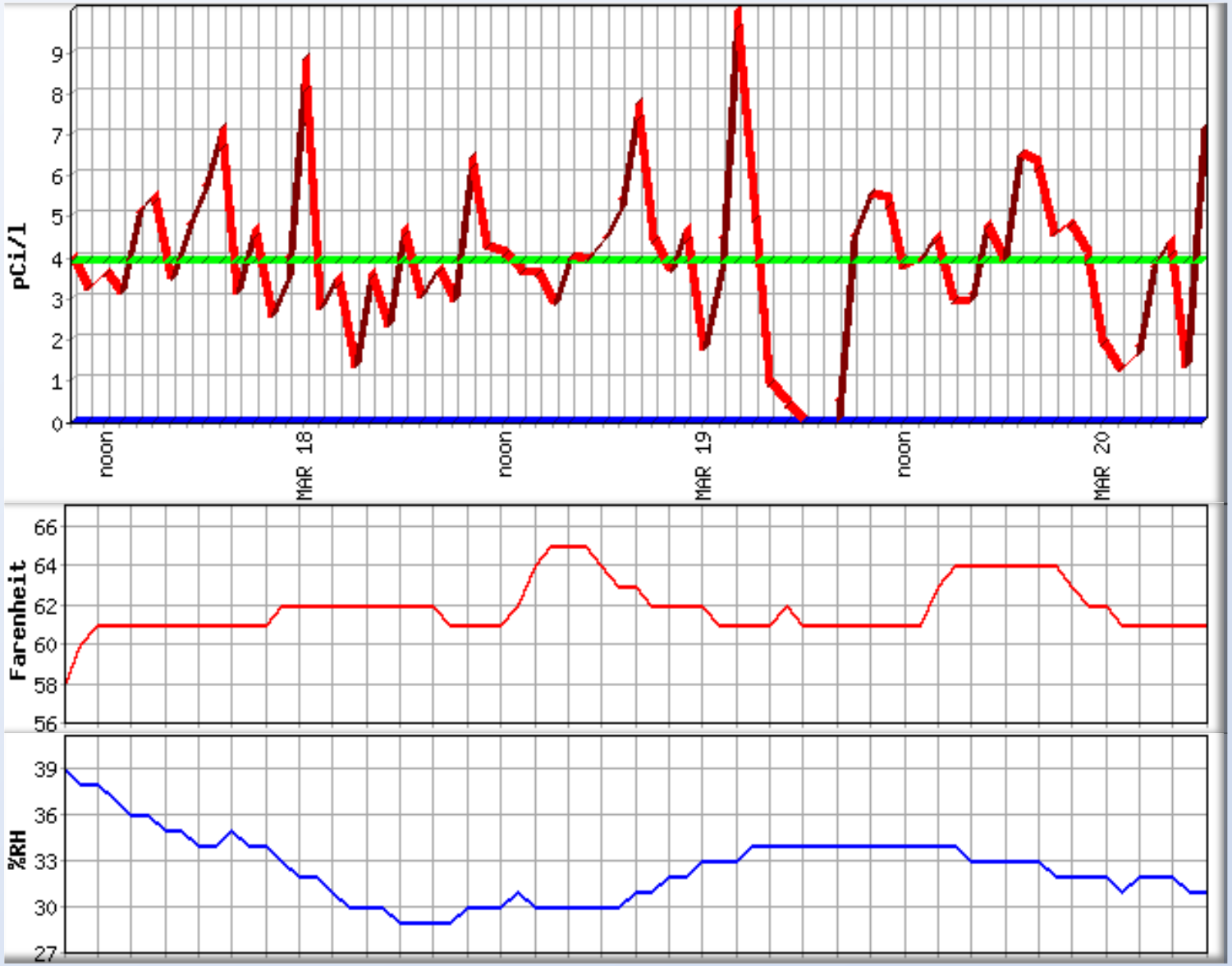
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Conclusions

- Early EPA research gave us a solid foundation
- Equipment has improved a great deal
- Property transactions often come with tight timelines
- Nature, weather and human, can add uncertainty to the mix
- Building dynamics and materials also impact the tests
- While 2-day testing can provide reliable results in most cases, sometimes we wish we had let the tests run an extra day or two

Thank you!

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