Radon Installation in New Construction of Multifamily, School, Commercial, and Mixed-Use Buildings

Presented by: Matt Koch

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Background / Objectives

- This presentation is focused on radon installation and testing in new construction
- Radon standards evolution
- How the type of building affects design and installation
- Requirements for design and installation
- Challenges in dealing with a **“BAD”** design
- Post construction process

Different Radon Design Standard

- EPA-600-R-97-124 Large Building Radon Manual (1977) (Archived)
- EPA 625-R-92-016 - Radon Prevention in the Design and Construction of Schools and Other Large Buildings (1994)
- ASTM E1465 - Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings (Withdrawn 2017 without replacement)
- ANSI/AARST CC-1000 2018 Rev.5-23 - Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings (Current)
- International Mechanical Code (IMC) Section 512 – SUBSLAB SOIL GAS EXHAUST SYSTEMS

Parameters Affecting Design

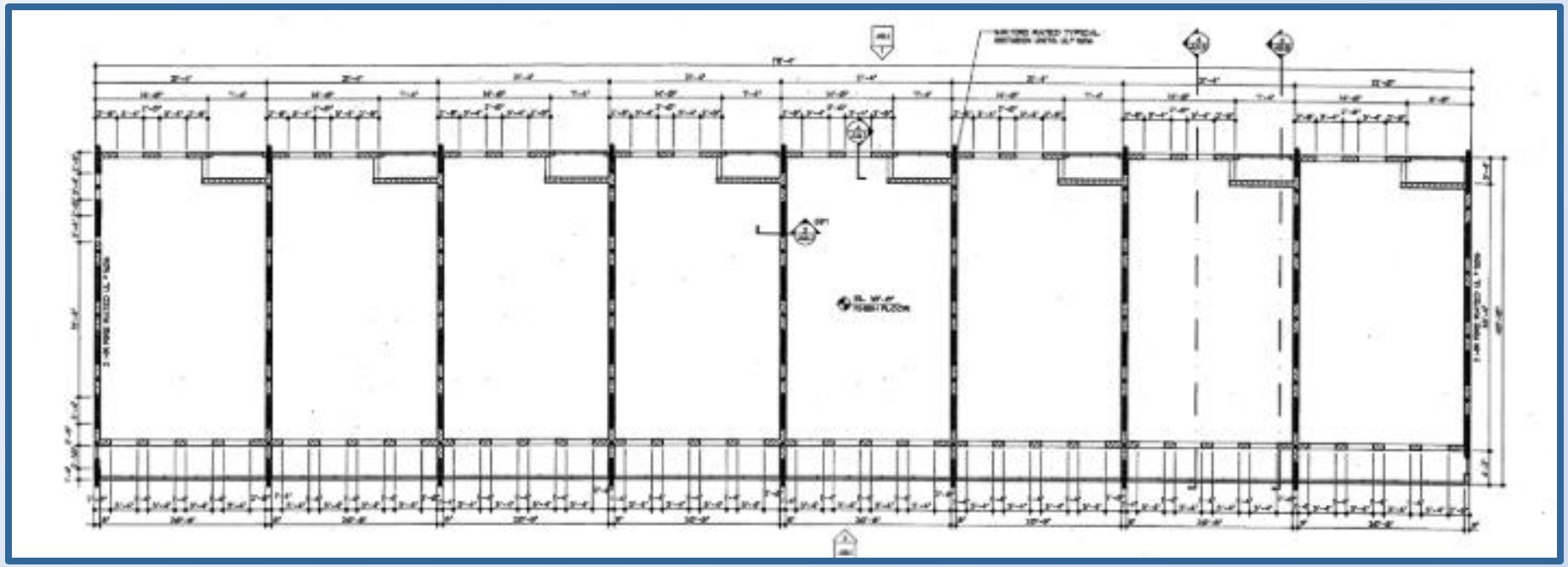
- Size and shape of the building
- Different building types on the same project
- Specific design/construction of structure/foundation
- Materials used sub-slab

Parameters Affecting Design

Size and shape of the building

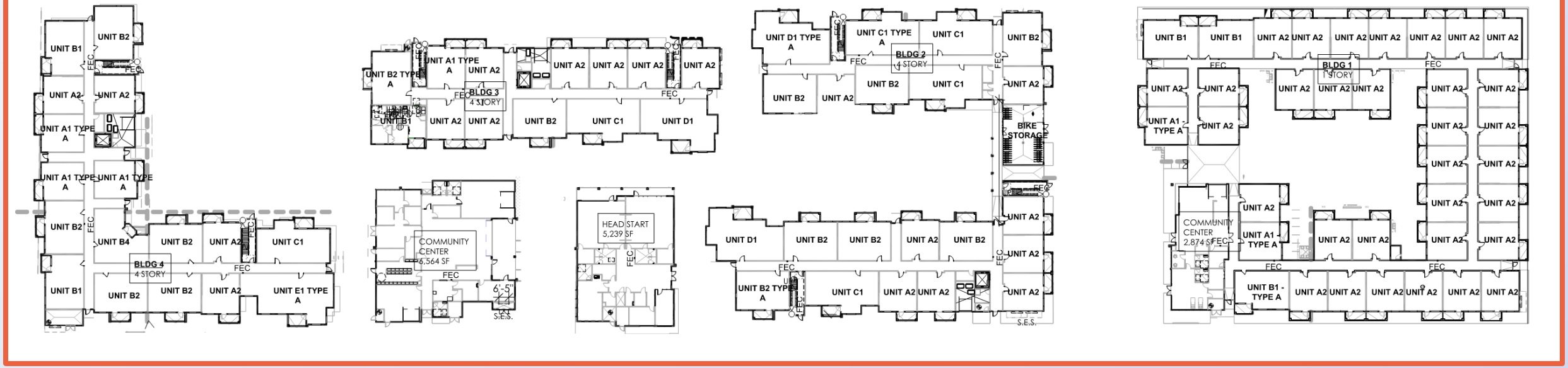
Parameters Affecting Design

Townhomes – For rent or for sale? House power?



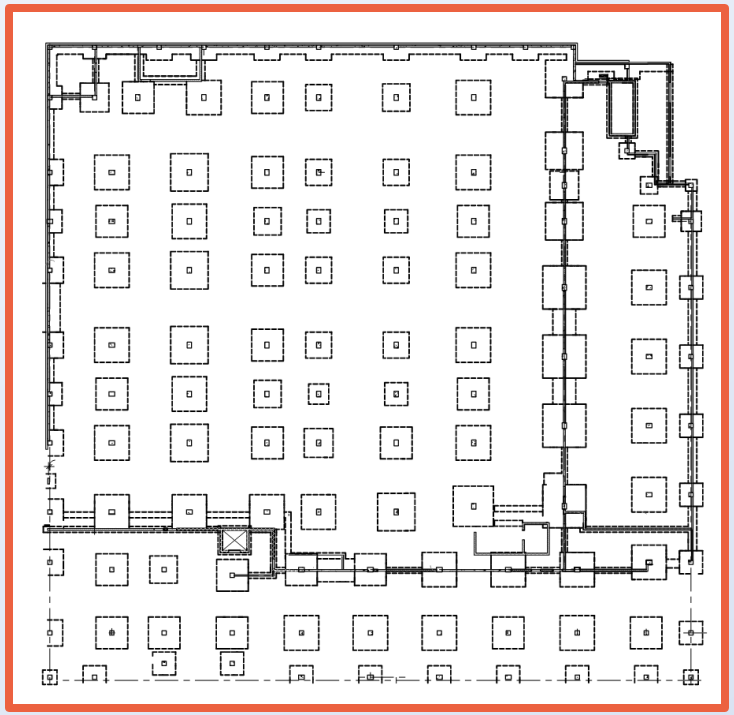
Parameters Affecting Design

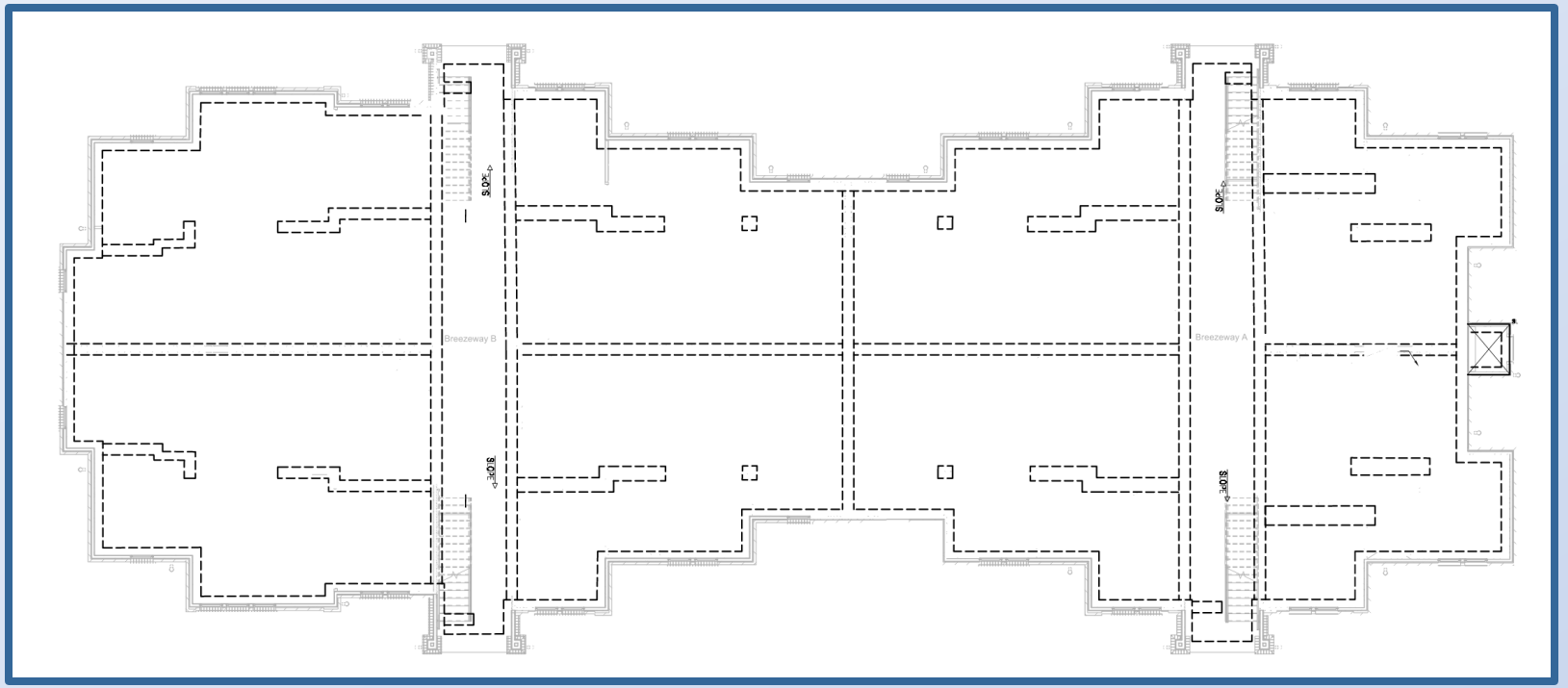
Different building types on the same project



Parameters Affecting Design

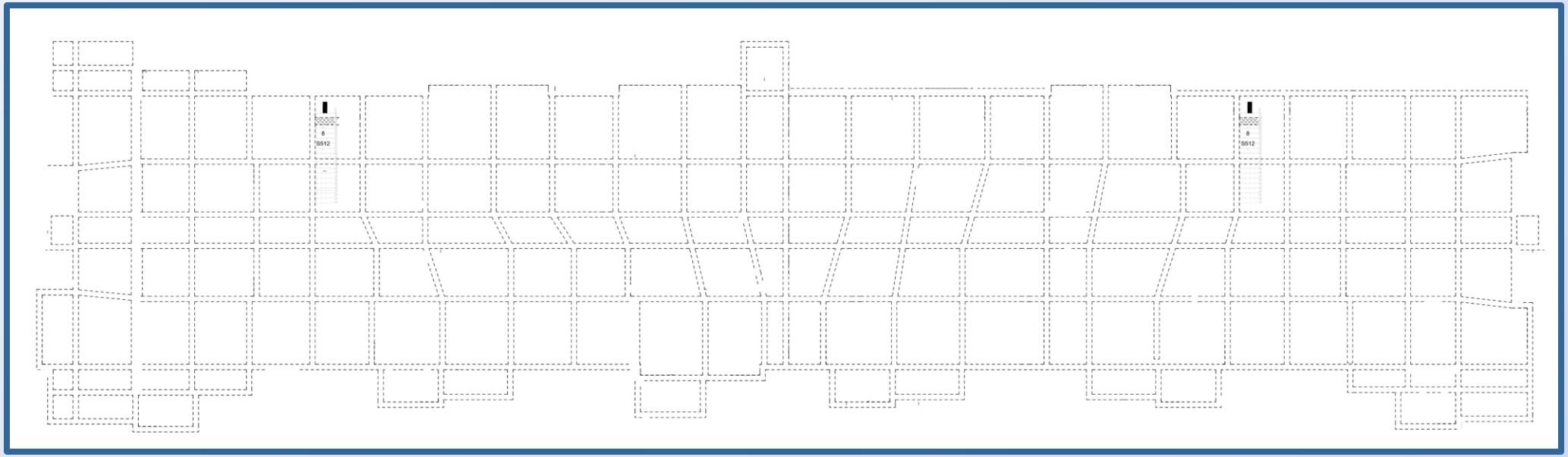
Specific design/construction of structure/foundation





Parameters Affecting Design

Specific design/construction of structure/foundation

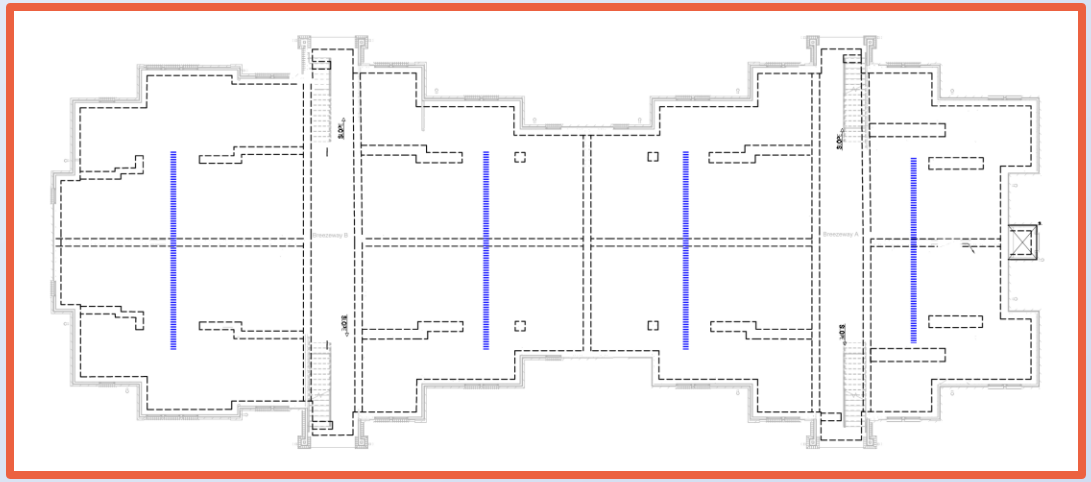


ANSI/AARST CC-1000

- Provides guidance on materials/methods
- Standards for pipe and plenum sizing
- Prescriptive method of verifying performance
- Pressure field extension (PFE) testing – quantifies airflow and fan sizing
- Inspections required during the process
- Post construction documentation requirements
- Post construction radon testing

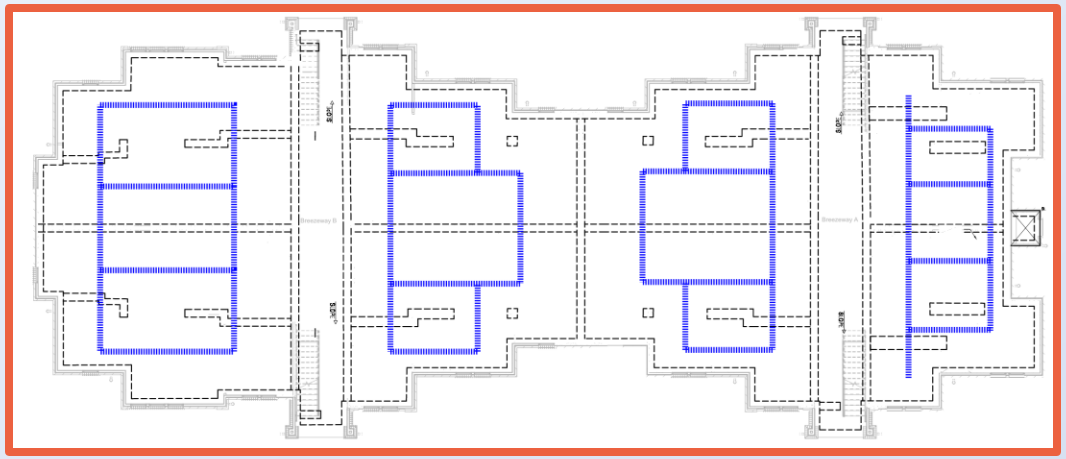
ANSI/AARST CC-1000

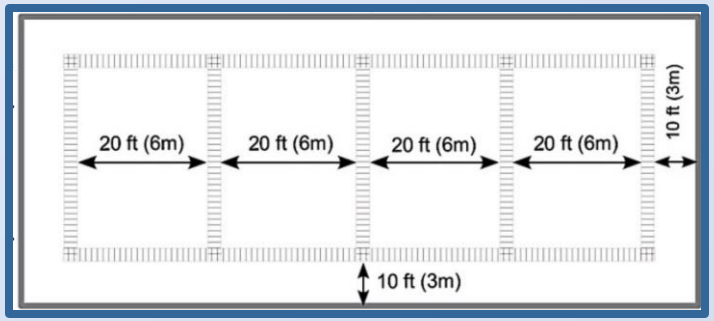
- Gas permeable layer – Material used changes sub-slab layout
- Typical construction – Aggregate - #57 stone
  - Every sub-slab cell must be connected to venting system
  - Minimum amount of venting in each area



Parameters Affecting Design

- Sand or native soil
  - No place more than 10’ from venting system





ANSI/AARST CC-1000

Standards for pipe and plenum sizing

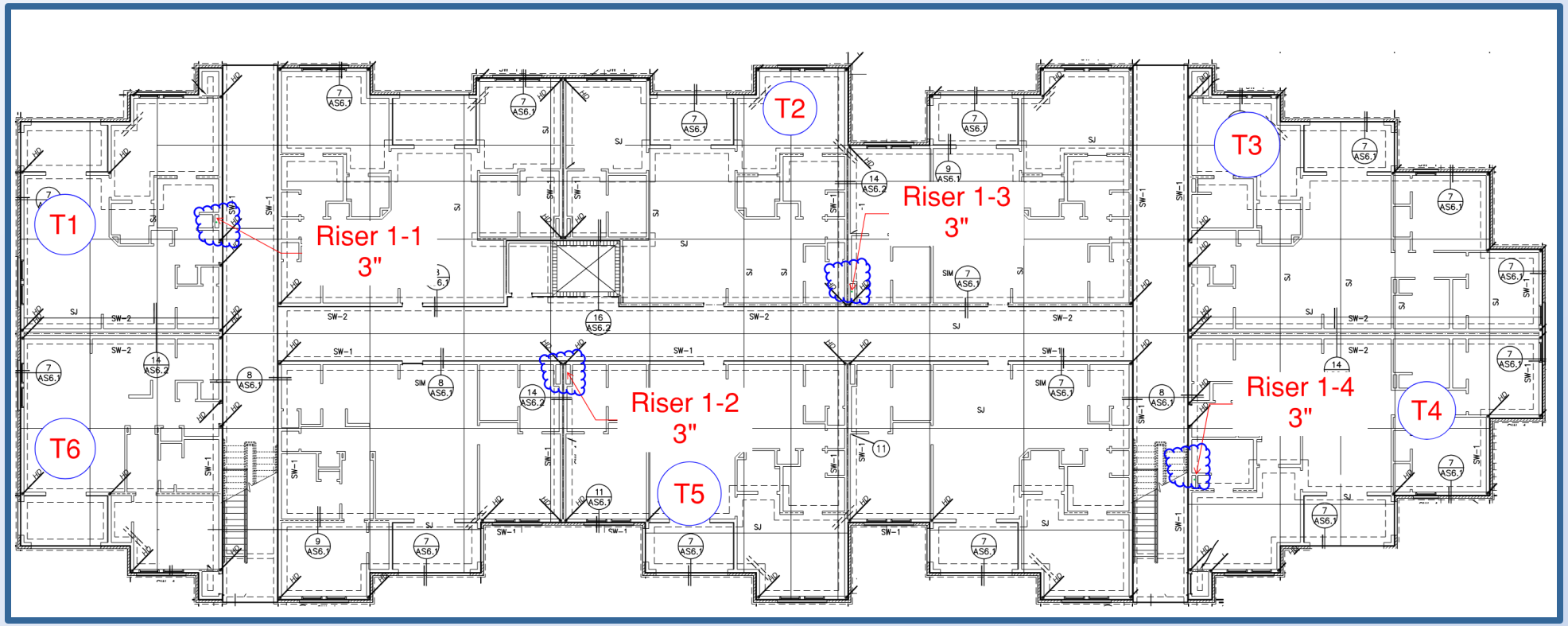
Table 4.3	Plenum Size Restrictions	
Nominal inside pipe diameter	Maximum size of Soil Gas Collection Plenum(s) per duct size	
	Where compliant plenum installation is verified by inspection per Section 5.10.2	Size allowed where gas-tight plenum closure, per Section 6.3.2, is also provided
3 inch (7.6 cm)	3,500 square feet (325 m^2)	4,000 square feet (372 m^2)
4 inch (10.2 cm)	6,200 square feet (575 m^2)	7,100 square feet (660 m^2)
6 inch (15.2 cm)	14,000 square feet (1,300 m^2)	16,000 square feet (1,486 m^2)
	Where any plenum installation is not verified by inspection per Section 5.10.2	Penalty for non-compliant gas permeable layer per Section 5.5
3 inch (7.6 cm)	2,500 square feet (232 m^2)	1250 square feet (116 m^2)
4 inch (10.2 cm)	4,500 square feet (418 m^2)	2250 square feet (209 m^2)
6 inch (15.2 cm)	10,000 square feet (929 m^2)	5,000 square feet (465 m^2)

ANSI/AARST CC-1000

- Pressure field extension testing – quantifies airflow and fan sizing
  - Connect fan to riser and measure PFE across the slab with micromanometer
  - Test ports in each quadrant, minimum 1 test port per riser
  - For post-tension slabs pre-installed test ports are used
  - Data recorded and used to select fans if needed
  - Any location where PFE is poor to be evaluated by mitigation professional and changes made to the number and/or locations of exhaust vent risers

ANSI/AARST CC-1000

PFE Testing



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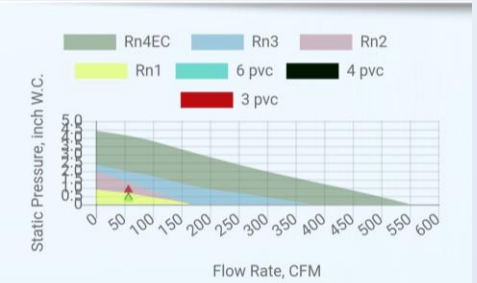
PFE Testing

ANSI/AARST CC-1000



2" pipe size
3" pipe size

Sub Slab Pressure Drop

Flow Rate, CFM (l/s)	*Pressure, Inch W.C. (Pa)*
57 (27)	0.30 (74)

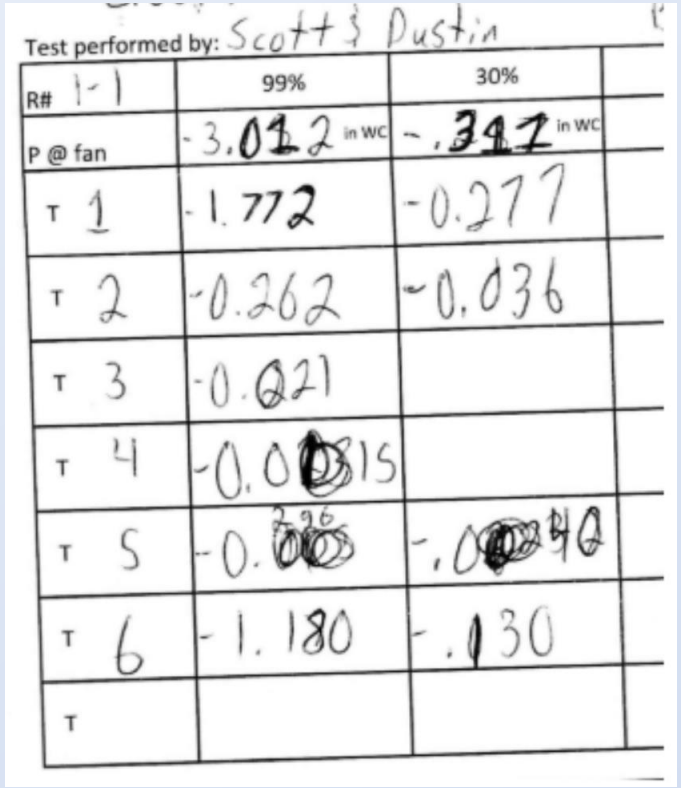
PVC Pipe Pressure Drop

Flow Rate, CFM (l/s)	*Pressure, Inch W.C. (Pa)*
57 (27)	0.58 (145)

Design Point

Flow Rate, CFM (l/s)	*Pressure, Inch W.C. (Pa)*
57 (27)	0.88 (220)

PFE Testing


Test performed by: Scott & Dustin

R# 1-1	99%	30%
P @ fan	-3.012 in WC	-.311 in WC
T 1	-1.772	-0.277
T 2	-0.262	-0.036
T 3	-0.021	
T 4	-0.0[illegible]15	
T 5	-0.[illegible]	-.0[illegible]40
T 6	-1.180	-.130
T		

Operation Point

Flow Rate, CFM (l/s)	*Pressure, Inch W.C. (Pa)*
67 (32)	1.21 (303)
57 (27)	0.88 (219)

Selected Fan

Rn2
Rn2EC

RPM Ratio

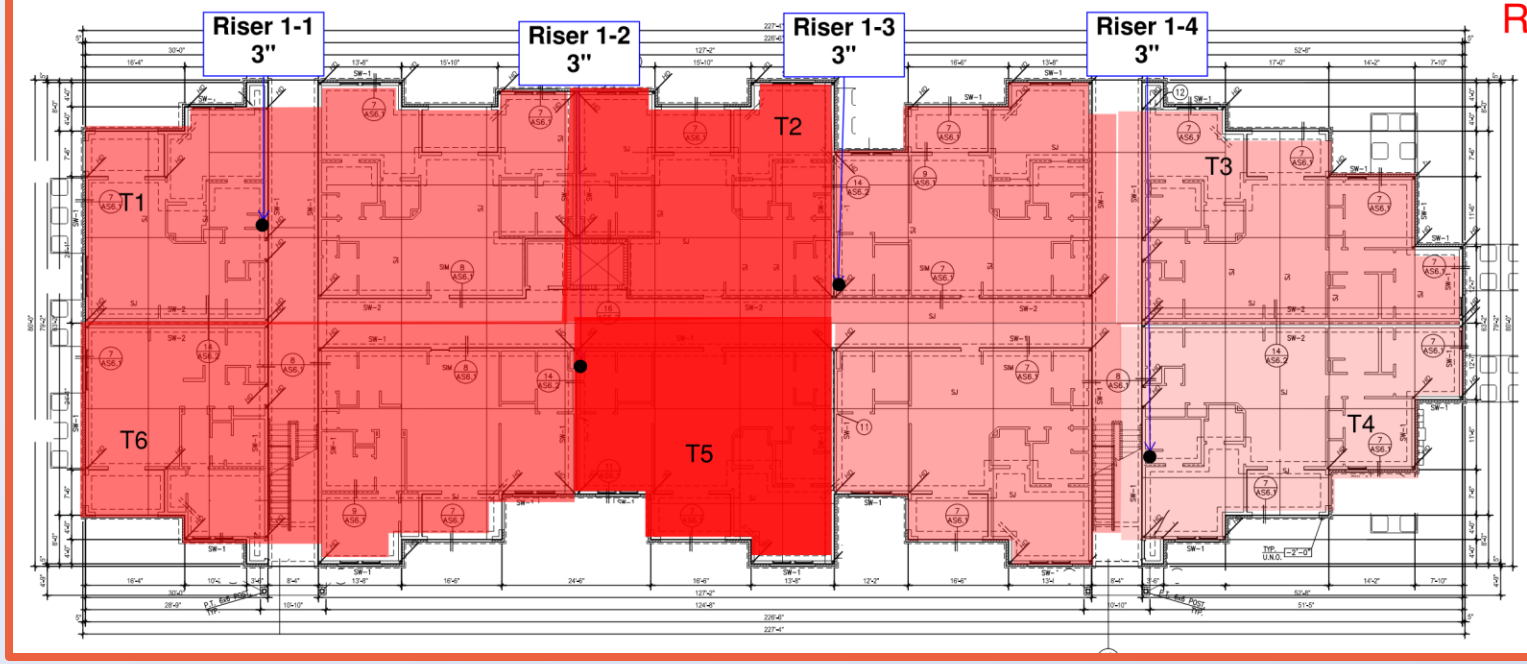
-
8

AC vs. EC Operation Energy Saving

-
$24

ANSI/AARST CC-1000

PFE Testing



RISER 2

R# 1-2	99%	30%	
P @ fan	-2.987 in wc	-.234 in WC	
T 1	-.498	-.041	
T 2	-1.283	-.292	
T 3	-.260	-.070	
T 4	-.178	-.066	
T 5	-1.891	-.393	
T 6	-.587	-.052	
T			

ANSI/AARST CC-1000

- Three inspections required as part of installation process
- Records to be provided to client as part of final documentation package
  - Sub-slab inspection – prior to casting the slab
  - Sealed plenum – no openings in slab prior to installing sheetrock
  - Exhaust vent risers – pipe installed correctly, labeled, electrical outlet provided, space for fan, exhaust correct

Why “BAD” Designs Happen?

- Nobody intends a bad design (at least most of the time)
- Lack of understanding of how systems work
- We have always done it this way
- Designer has never installed a system in the field
- Lack of PFE testing to verify a system will work
- Over-engineering
- Under-engineering

Why “BAD” Designs Happen?

- Not familiar with CC-1000
- Anyone who takes the three-day course is a radon professional
- The status quo is that the designer can put just about anything they want down on paper and it is considered a “**GOOD**” design

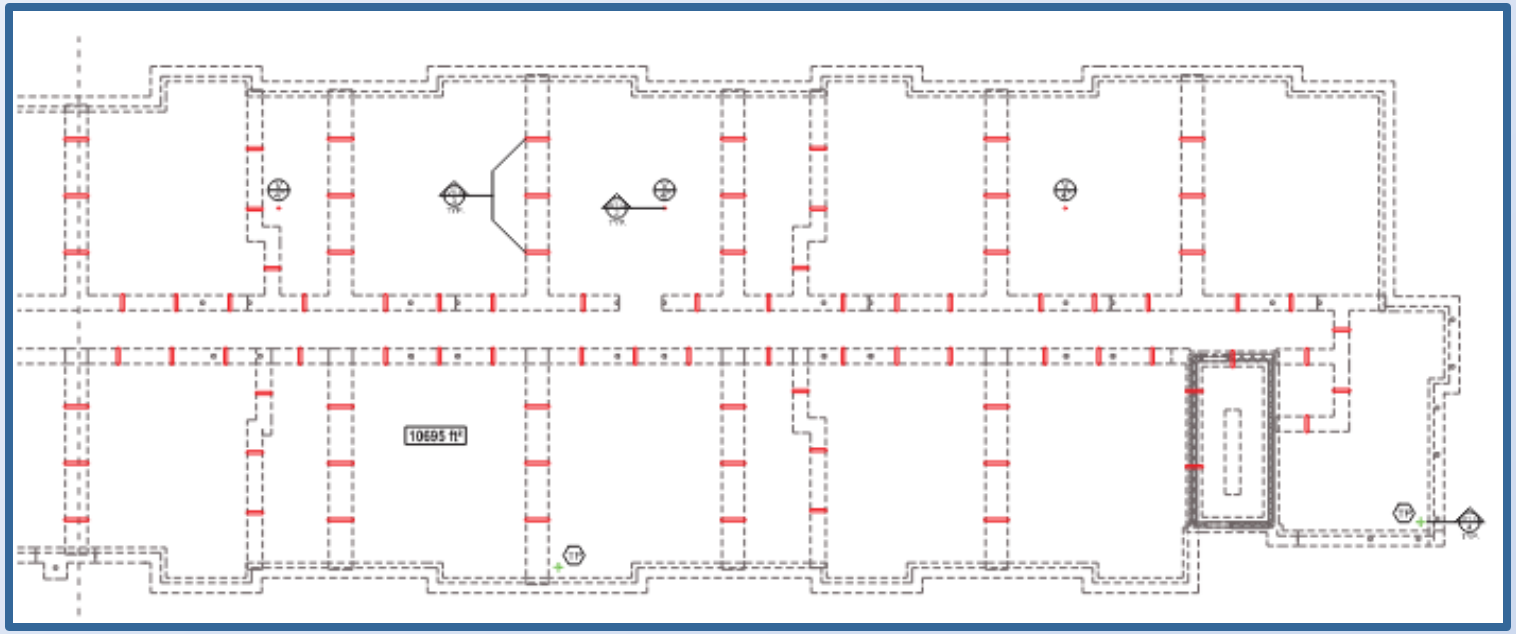
How to Identify a “BAD” Design

- Does not conform to CC-1000
- Conforms to outdated/withdrawn standards
- Risers in exterior walls
- Wrong size/number pipe risers for size of plenum served
- Areas of a building are not included in the plan
- Does not specify PFE testing requirements or locations
- Does not specify locations for future monitors
- Looks pretty on paper, difficult to install in the field

How to Identify a “BAD” Design - Design Basis Incorrect

What is wrong here?

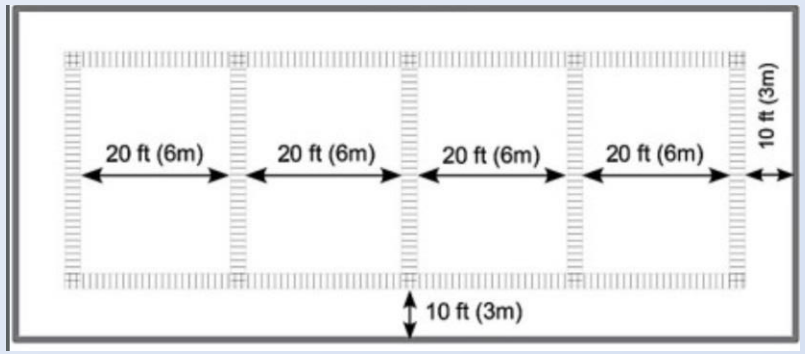
This stipulated that the design and specifications meet the requirements of CC-1000.
It also identified that the “Radon Professional” designer is NRPP certified.



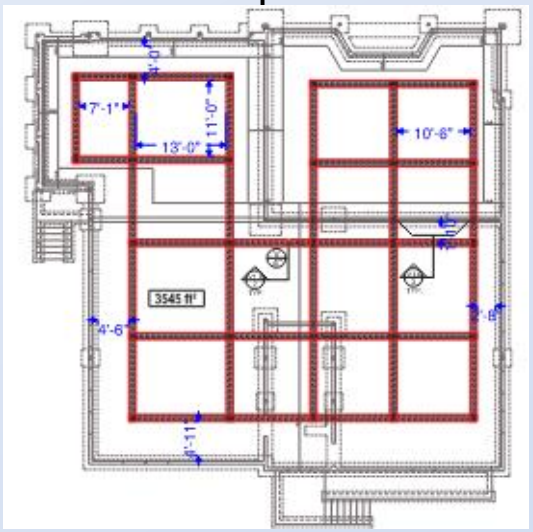
How to Identify a “BAD” Design - Design Basis Incorrect

- Design is for a building with sand
- Building has 4-inches of #57 stone
- 3-inch pipe is correct for plenum size
- Design calls for 4-inch pipe located in 2x6 wall
- This design is a good candidate for a VE option

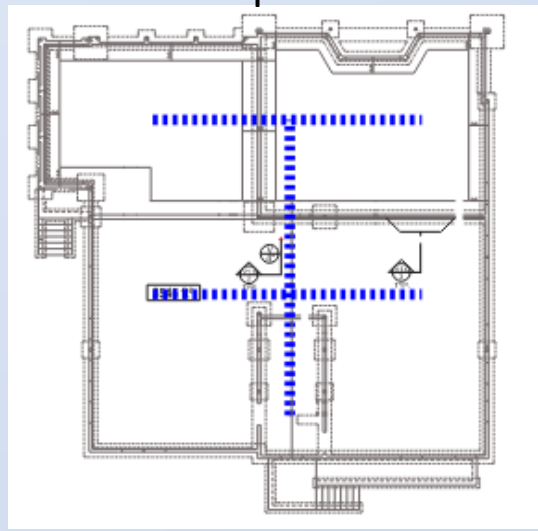
Table 5.5.3
Requirements For Alternative Gas Permeable Layers



495’ vapor mat

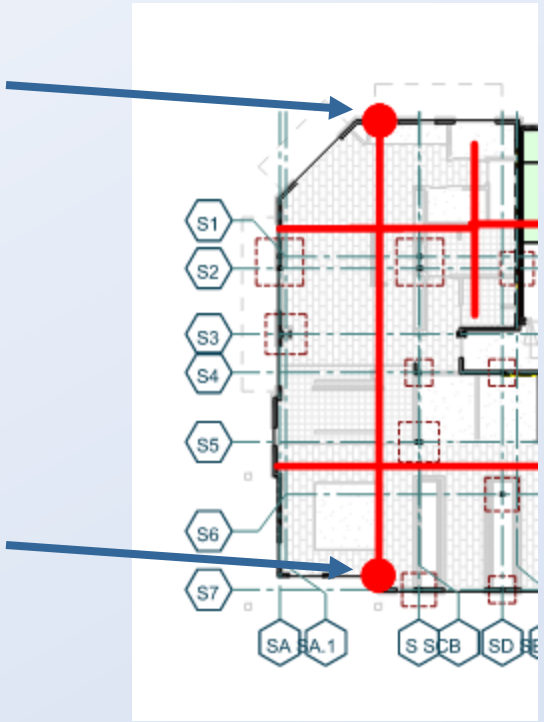


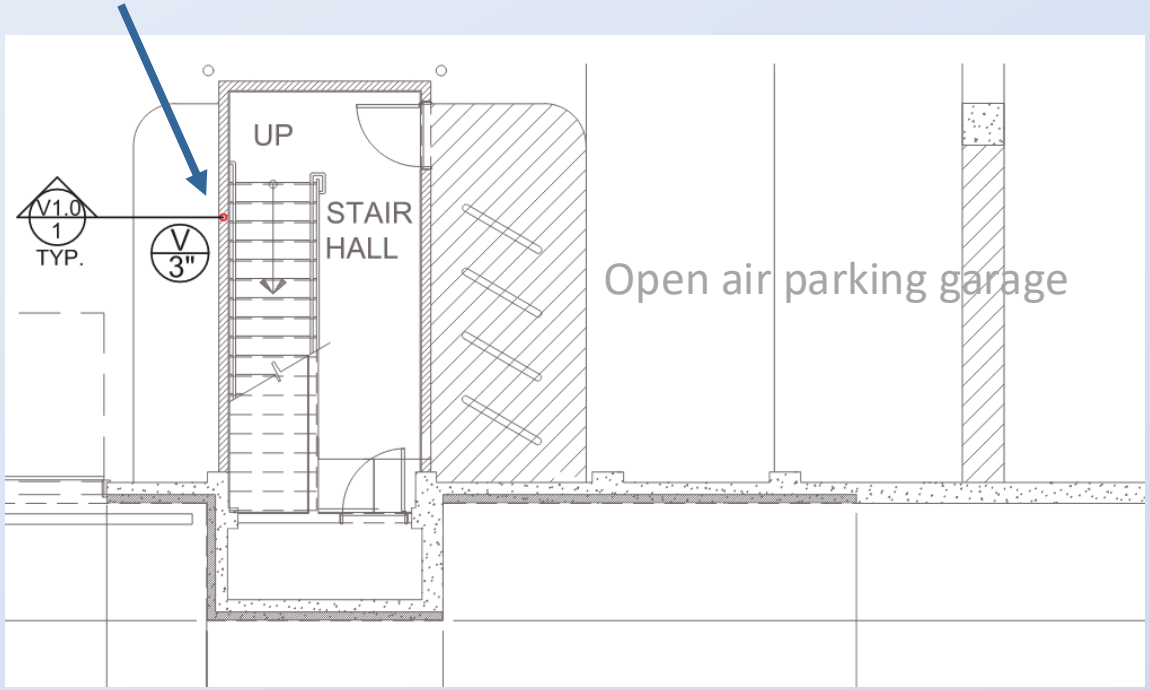
125’ vapor mat



How to Identify a “BAD” Design - Design Basis Incorrect

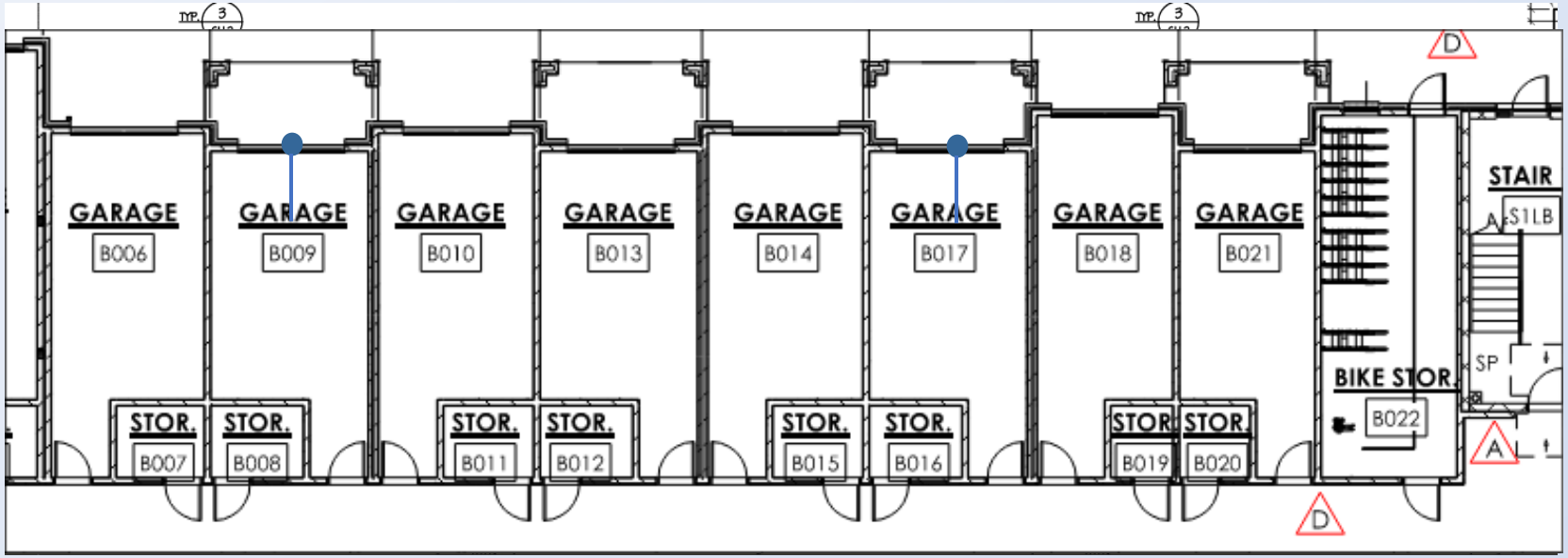
Risers in exterior wall – plans do not call for active system from time of installation

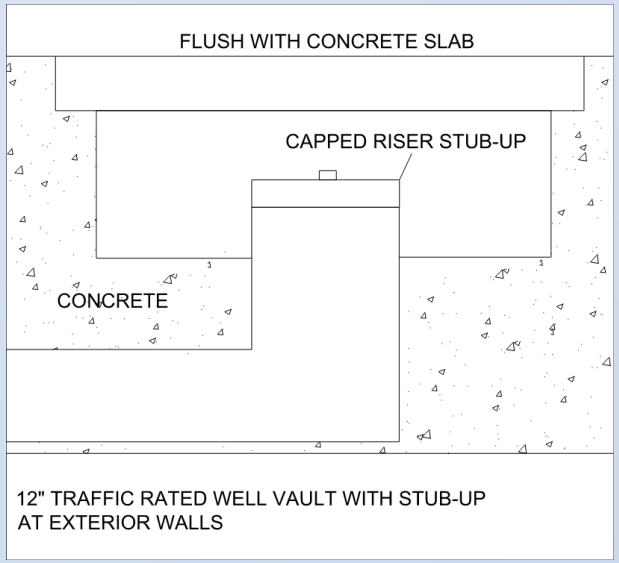




How to Identify a “BAD” Design - Design Basis Incorrect

- HUD project – should be CC-1000 compliant
- What is wrong here? How many different things can you identify?





Considerations When Speaking With Client About Bad Design

- Was the design given to the GC by the owner?
- They have already paid for the design, they won't want to pay again
- The person who did the design is "licensed/certified/engineer" therefore the design must be correct
- It was reviewed by the HUD reviewer and no problems identified
- They have always done it this way and never had a problem
- They don't really care/think it is needed

Post Construction

- Radon testing following ANSI/AARST *Protocol for Conducting Measurements of Radon and Radon Decay Product Testing in Commercial, Multifamily, School and Mixed-Use Buildings Standards* (MA-MFLB-2023)
- Review plans with installation in mind
- If any locations test high, a fan is installed according to results of PFE testing
- Retest the building

Post Construction Documentation

- Operation and Maintenance (O&M) Plan and Manual
- Radon testing results
- PFE test data
- Fan specifications for each riser
- Record of inspections

Take Aways

- If systems are designed correctly, they work if needed
- PFE testing verifies that the design and installation will work
- Post construction radon testing verifies that the system worked by lowering the radon levels

Any Questions?

To discuss these findings, please contact Matt Koch, at mkoch@cleanvapor.com

Thank you!