Mitigation Diagnostics for Schools & Large Buildings

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How do you design an ASD system for this 10 story building?

Lowest level
radon
12 to 24 pCi/L

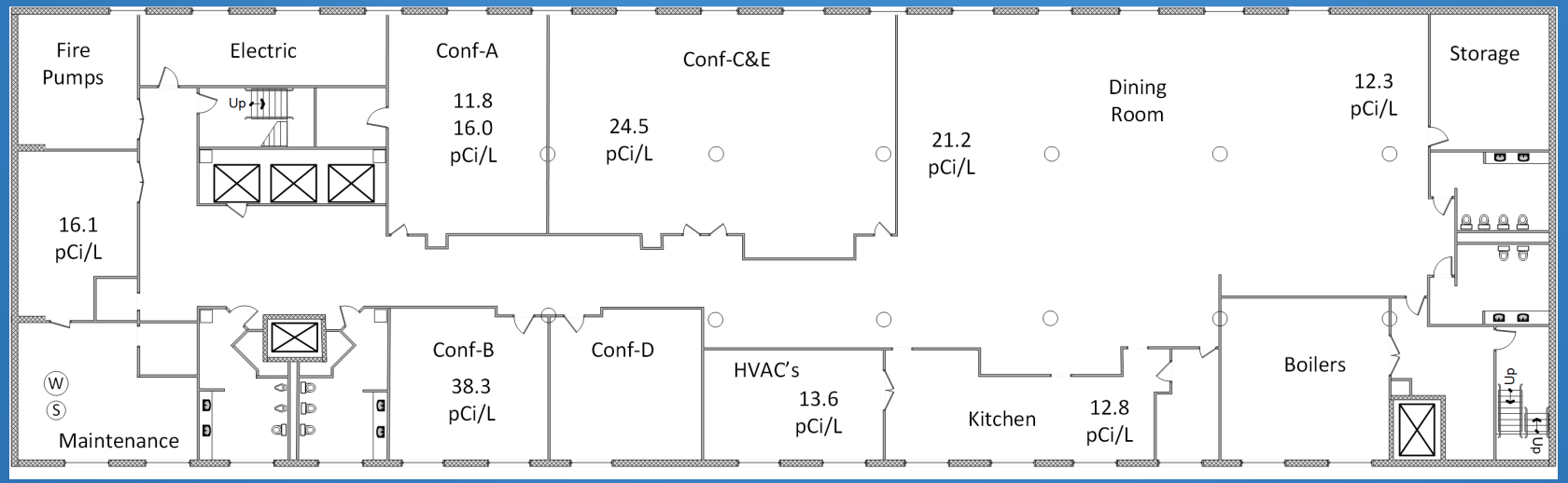
Owner requests
no outside piping?

Important Commercial Building Questions:

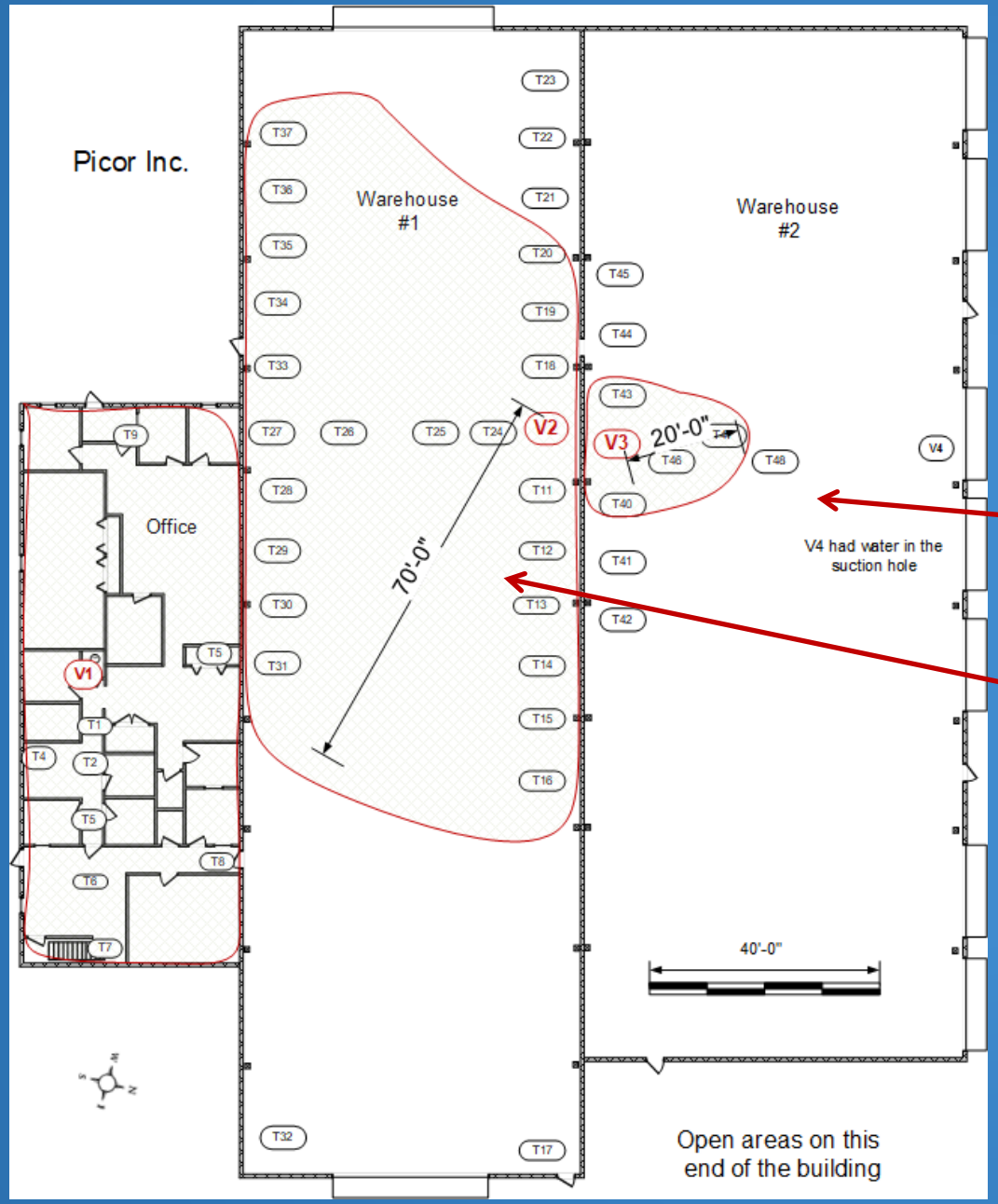
How old is the building?	1940 - 1950
Was there any additions?	No
Are there construction drawings?	No
Does HVAC provide outdoor air?	Yes but unknown
Can it be fixed with outdoor air?	No

<- 236 feet ->

16,520 Sq Ft



70 feet



Important PFE question

What is the PFE Radius of Influence?

ROI

20 ft ROI @ V3

1,250 Sq Ft

70 ft ROI @ V2

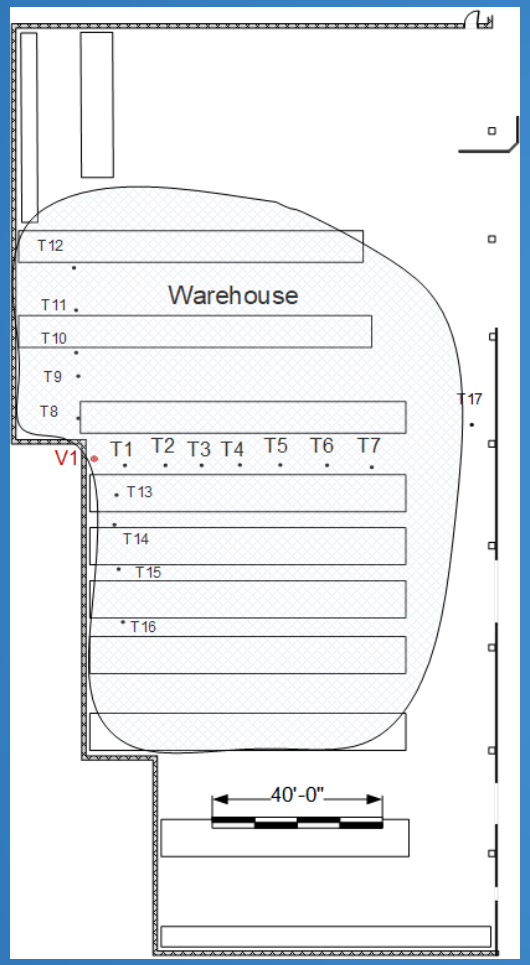
15,000 Sq Ft

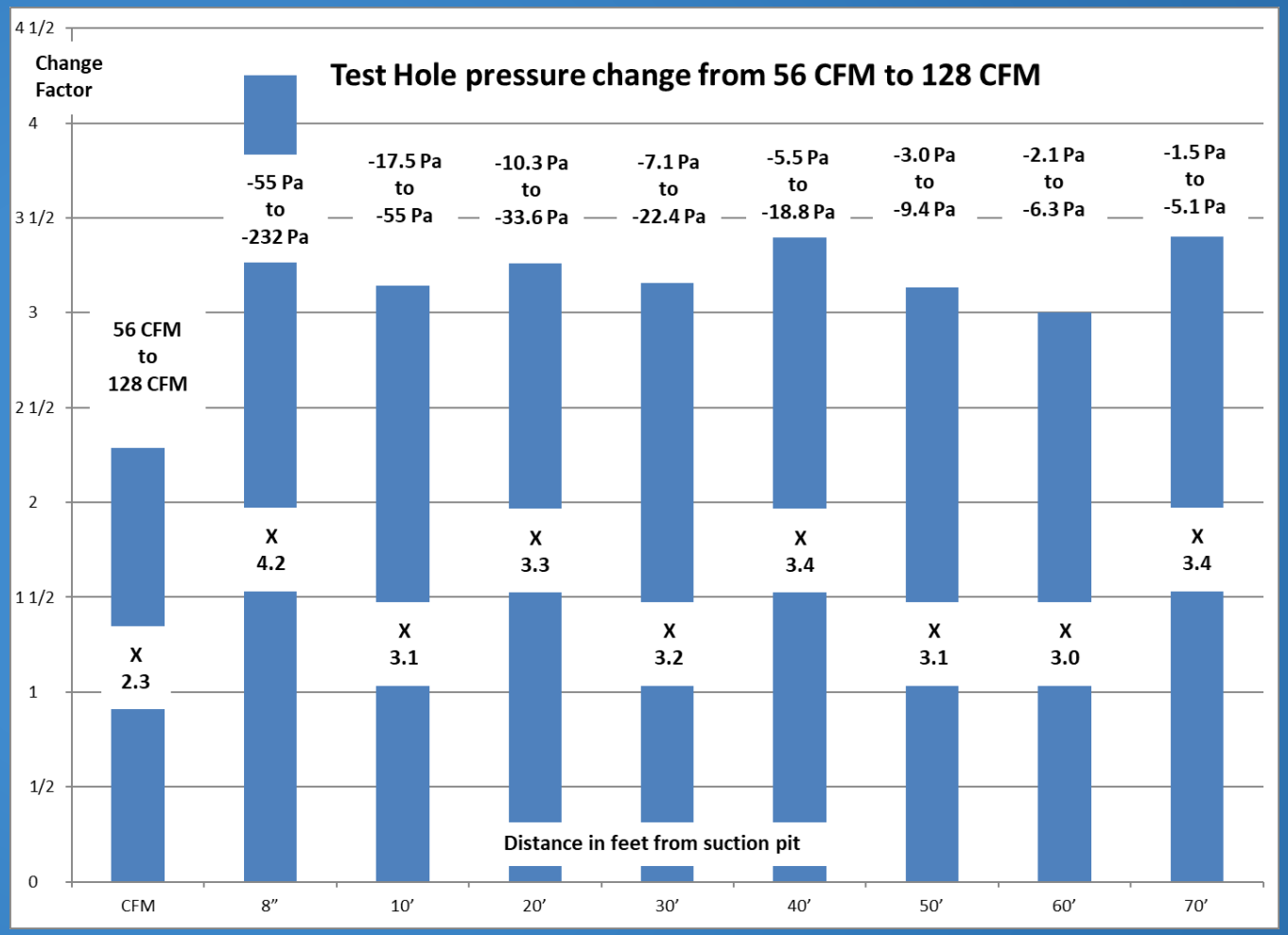
Need twelve V3 ROI suction pits to cover one V2 ROI area

A Larger fan may double CFM but will not double ROI

Rule:

Square of CFM change equals Pressure Change





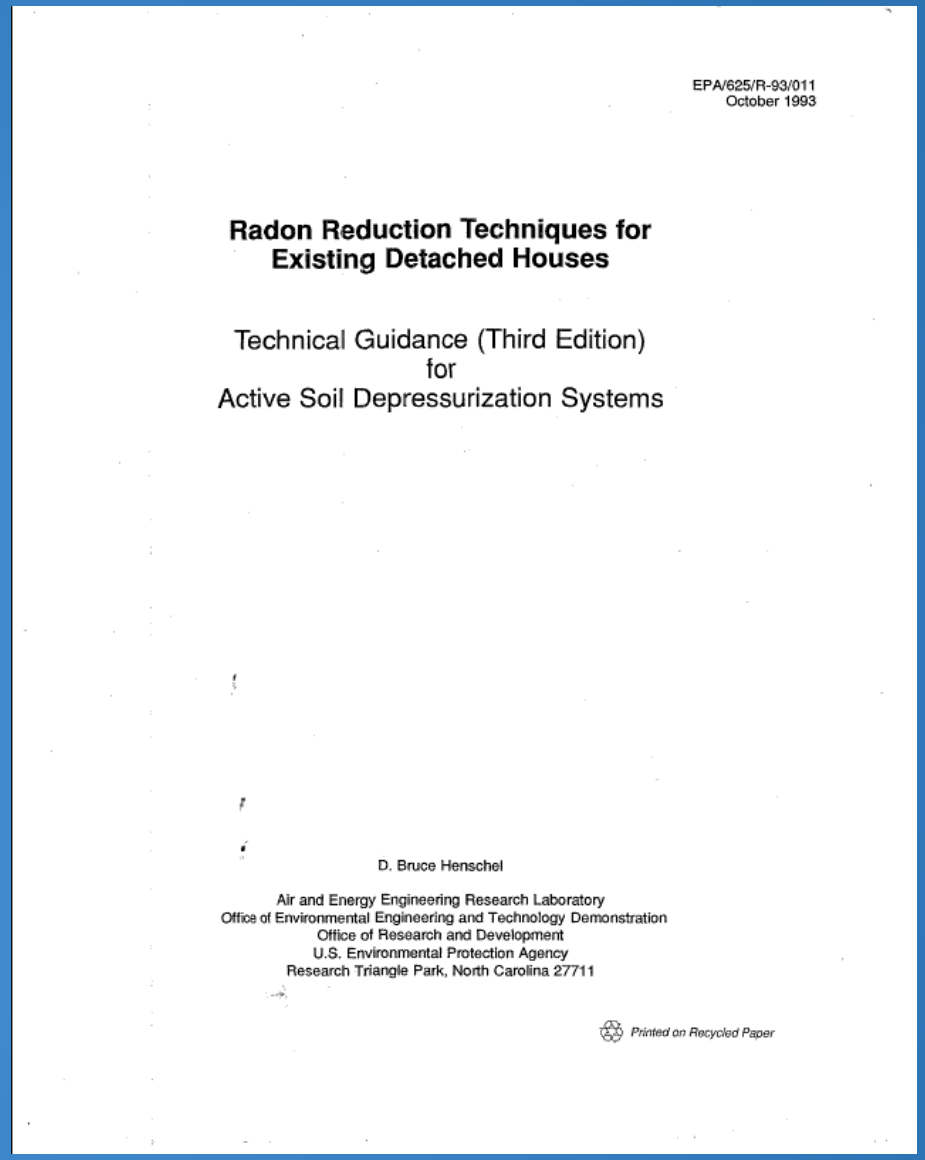
Airflow 2.3 X - Baseline 4.2 X - All Test Holes 3.1 to 3.4 X

PFE began 30 years ago

EPA published:
Bruce Henschel's

Residential ASD
Technical Guidance
on
Pressure Field
Extension (PFE).

Residential PFE Concepts
are
the same for
Commercial Buildings



EPA/625/R-93/011
October 1993

Radon Reduction Techniques for Existing Detached Houses

Technical Guidance (Third Edition)
for
Active Soil Depressurization Systems

D. Bruce Henschel

Air and Energy Engineering Research Laboratory
Office of Environmental Engineering and Technology Demonstration
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Thank you Bruce

Main Difference:

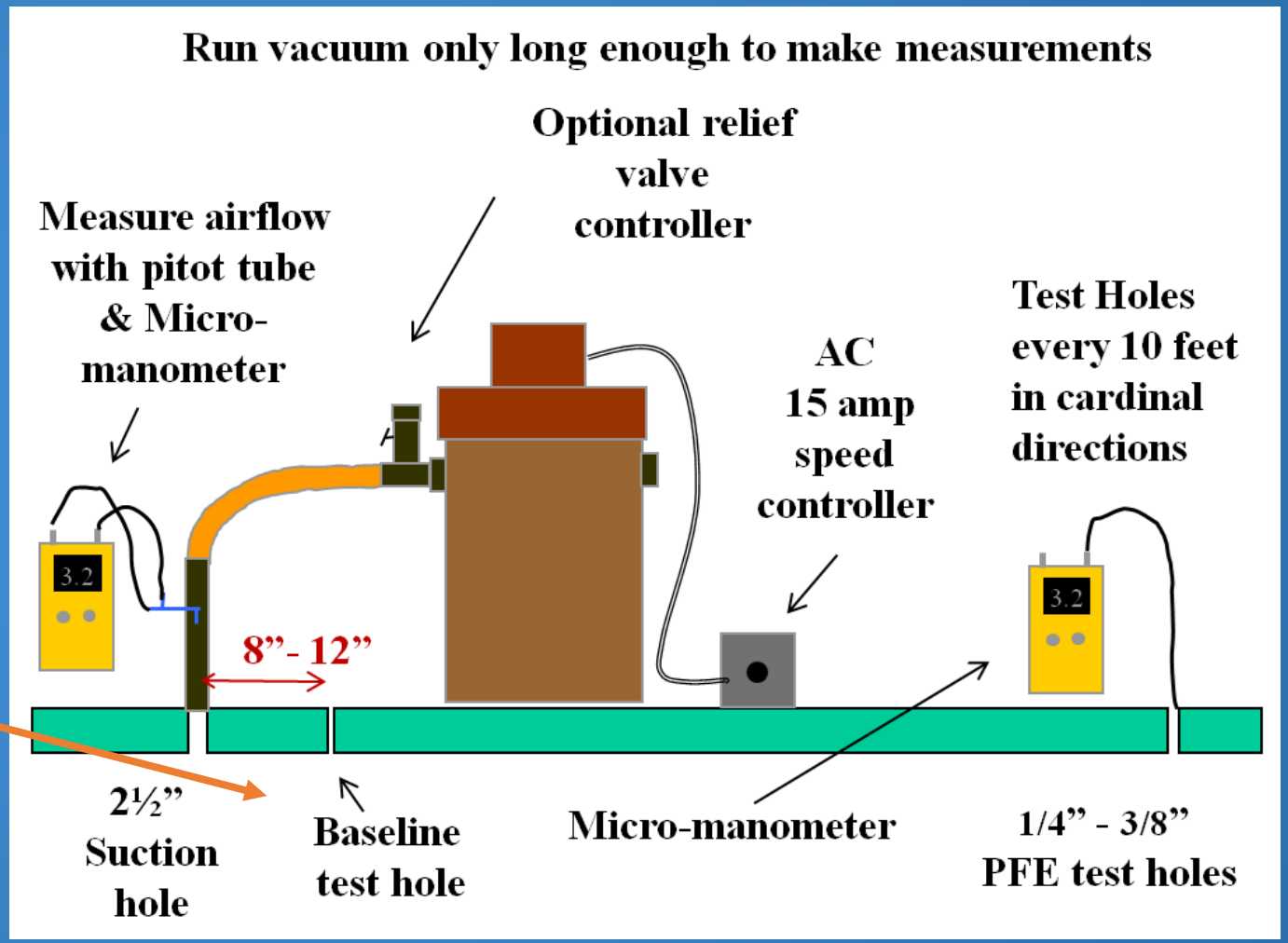
Residential: uses Suction pit PFE during installation

Commercial: makes Multi Pre-Installation PFE Tests

Commercial PFE:
Core 2.5”

Vacuum out
1 to 1.5 gallons

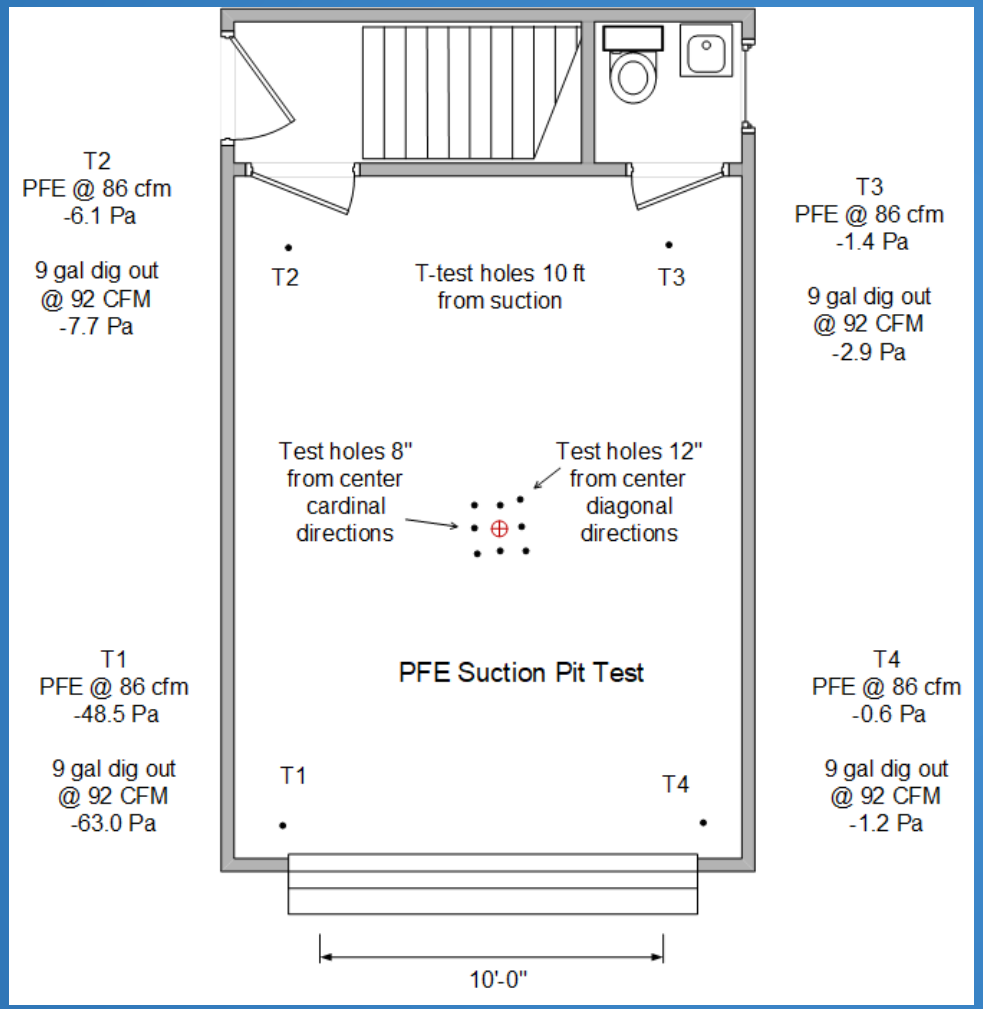
Measure
CFM
&
Baseline Pressure
=
Subslab
Airflow Resistance



Which Baseline test hole distance best simulates a dug out suction pit?

The Test

Measured
3
PFE Airflows
with
a pitot tube
in a
2” riser pipe.



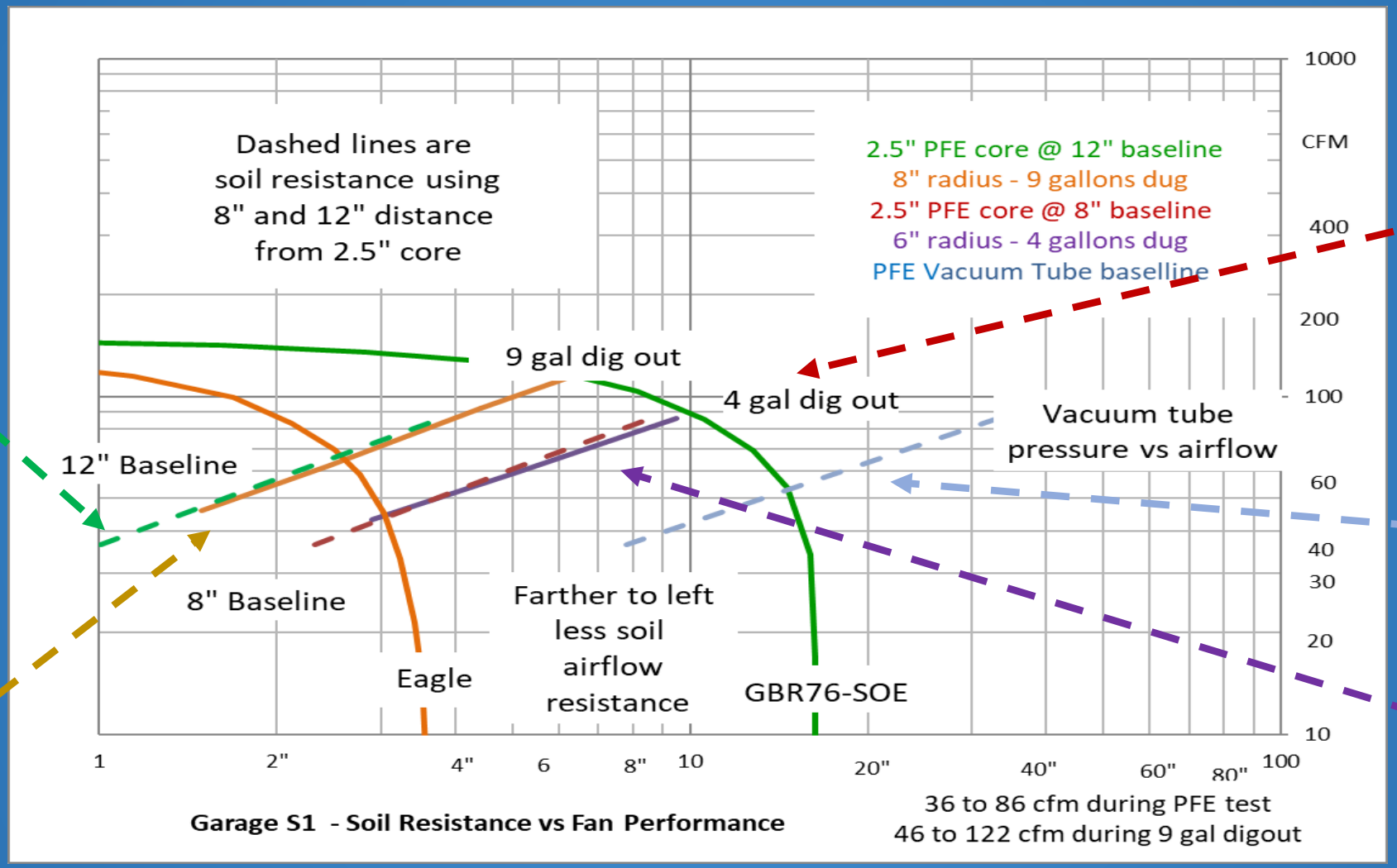
8” out or 12” out?

Measure Baseline Sub-Slab Pressure
8” & 12”

Comparison of Garage PFE results vs Dug Out suction pit

Green Dash 12” PFE baseline

Orange 9 Gal Dig Out overlaid 12”



Red Dash 8” PFE baseline

Wand Pressure Not Used

Purple

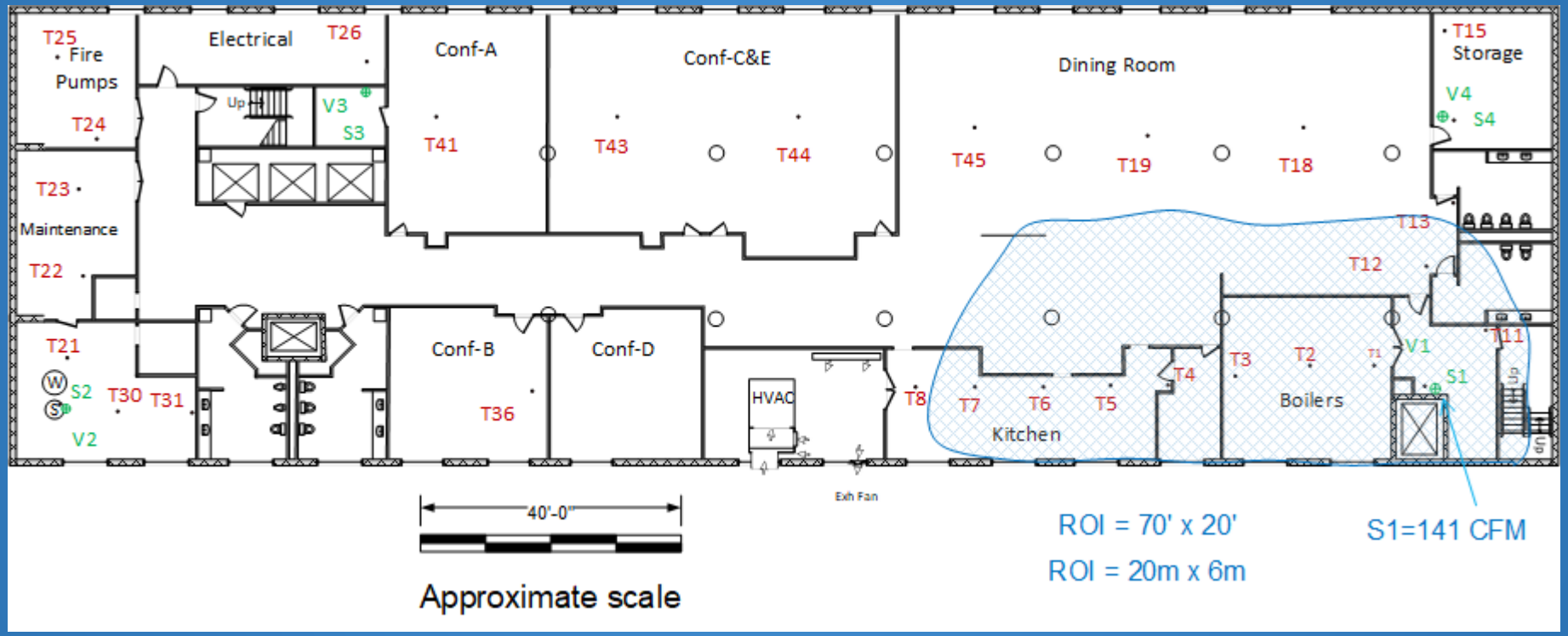
4 Gal Dig Out overlaid 8”

I recommend a Baseline Distance of 8”

10 Story Case Study S1 PFE

Vacuum off test holes +4 to +7 PA DR +20 Pa

Building pressure In to Out was – 34 Pascals

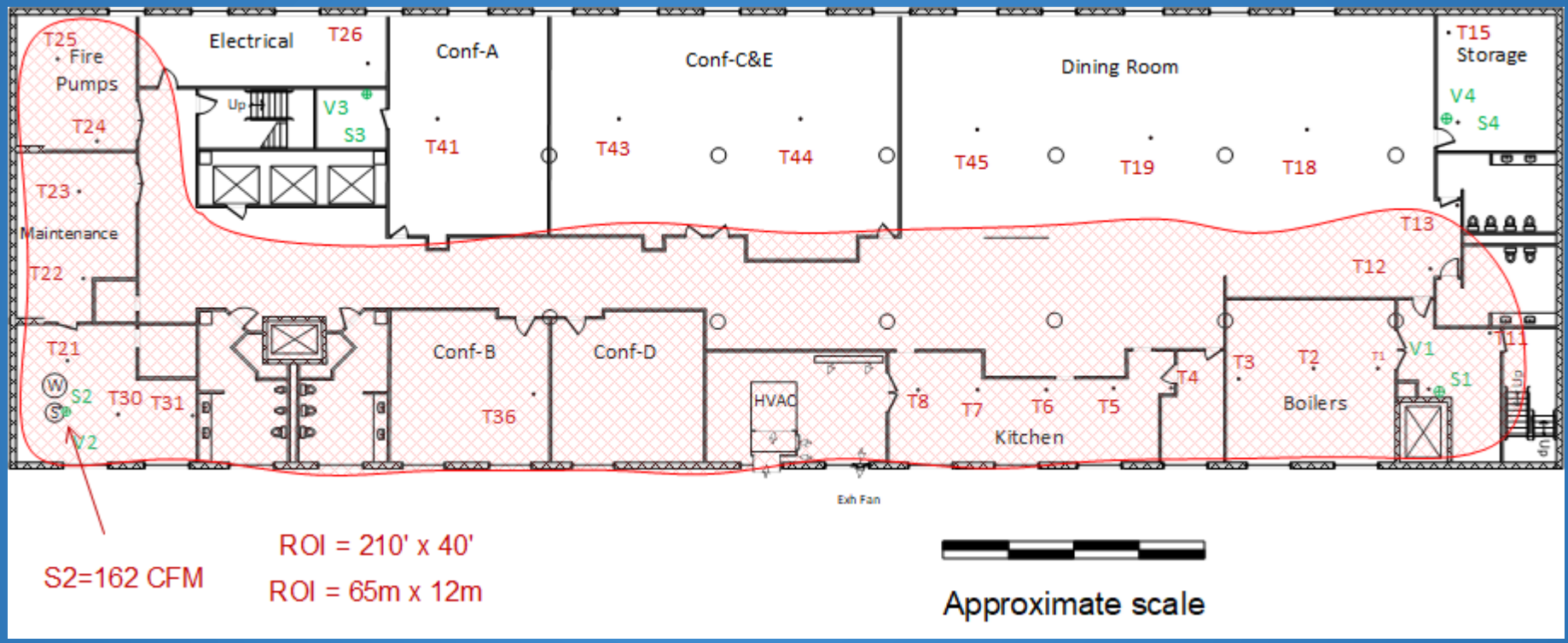


S1- 141 CFM & ROI 20’ X 70’

Case Study S2 PFE

210 foot ROI

S2 used a sump pit for PFE test



S2 airflow 162 CFM S1 airflow 141 CFM

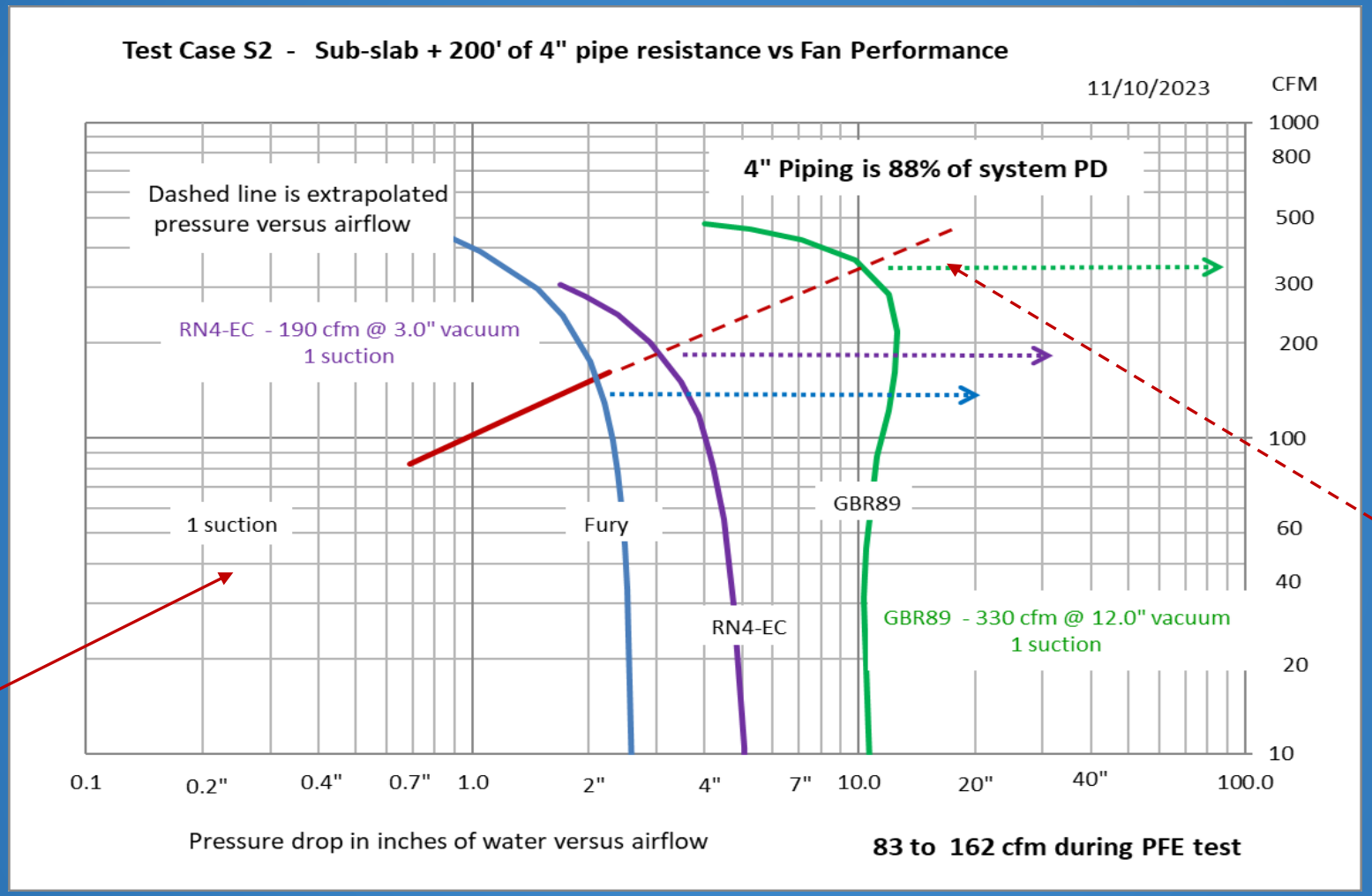
8” Baseline only 0.28” SP - S1 0.52” SP

Case Study S2 PFE

Baseline Sub-Slab 0.28”

200 ft of 4” piping is 2.0” Pressure Drop

4” Piping is 88% of Total System airflow resistance



Solid Red is PFE test + piping

Dashed is extrapolated higher airflow

GBR89 can move 340 CFM versus 162 CFM during PFE Testing

Case Study S3 PFE

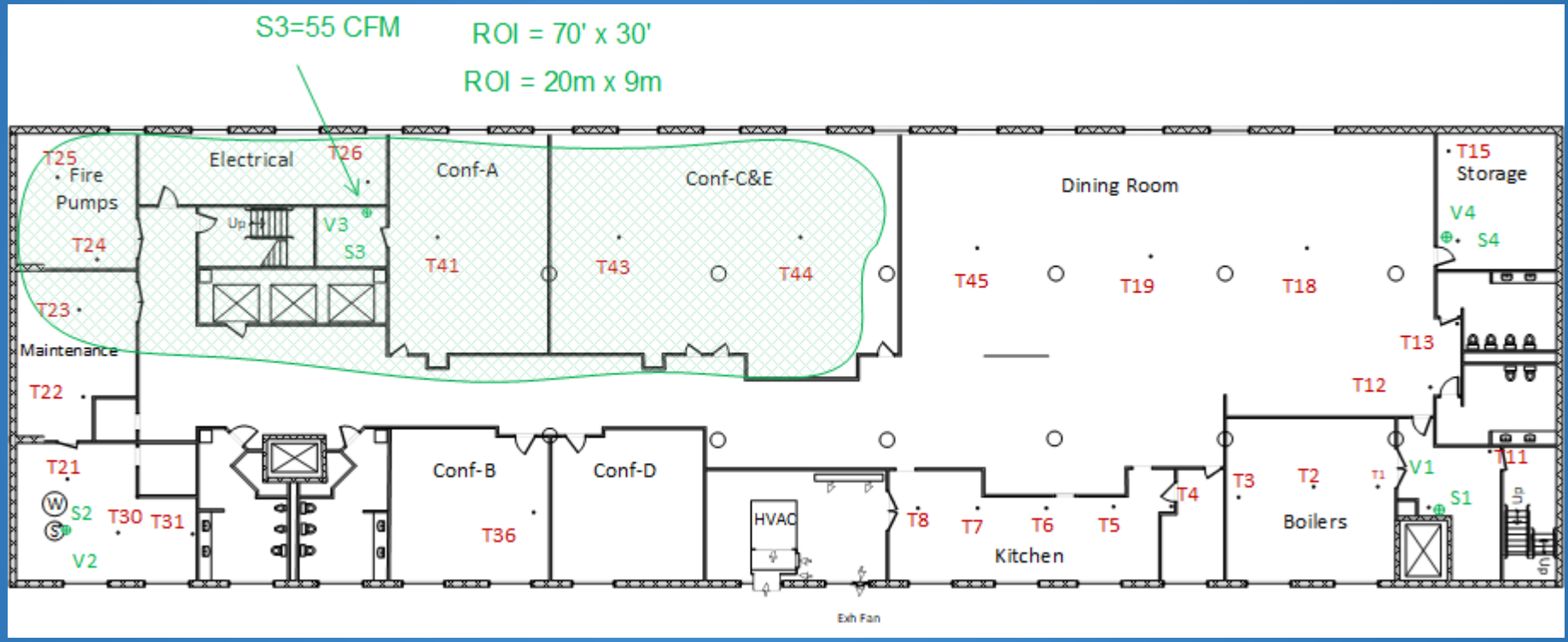
S2 ROI = 40’ X 210’ = 8400 ft²

vs

S3 ROI = 30’ X 70’= 2100 ft²

4X different sq ft

Very Different Results



S2 = 55 CFM vs S3 = 162 CFM

3X different CFM

8” Baseline S2 = 6.4” SP vs S3 = 0.28” SP

20X different SP

Case Study S3 Fan & Piping Size

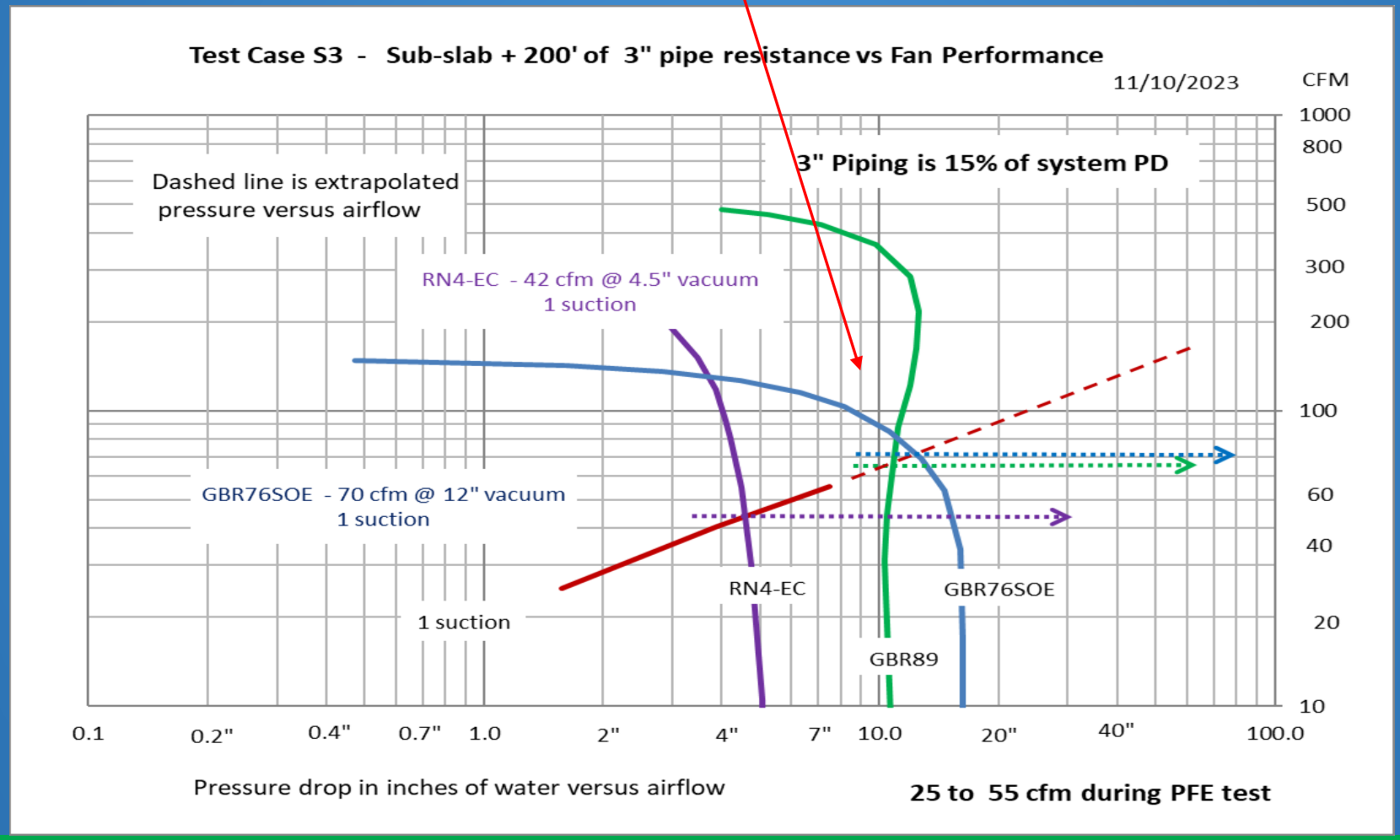
Big Difference in fan choice

GBR76 SOE = 300 watts

GBR89 = 1000 watts

S3 - Baseline = 6.0” SP

200 ft of 3” piping = 1.5” SP



3” Piping only 15% Total System Airflow Resistance

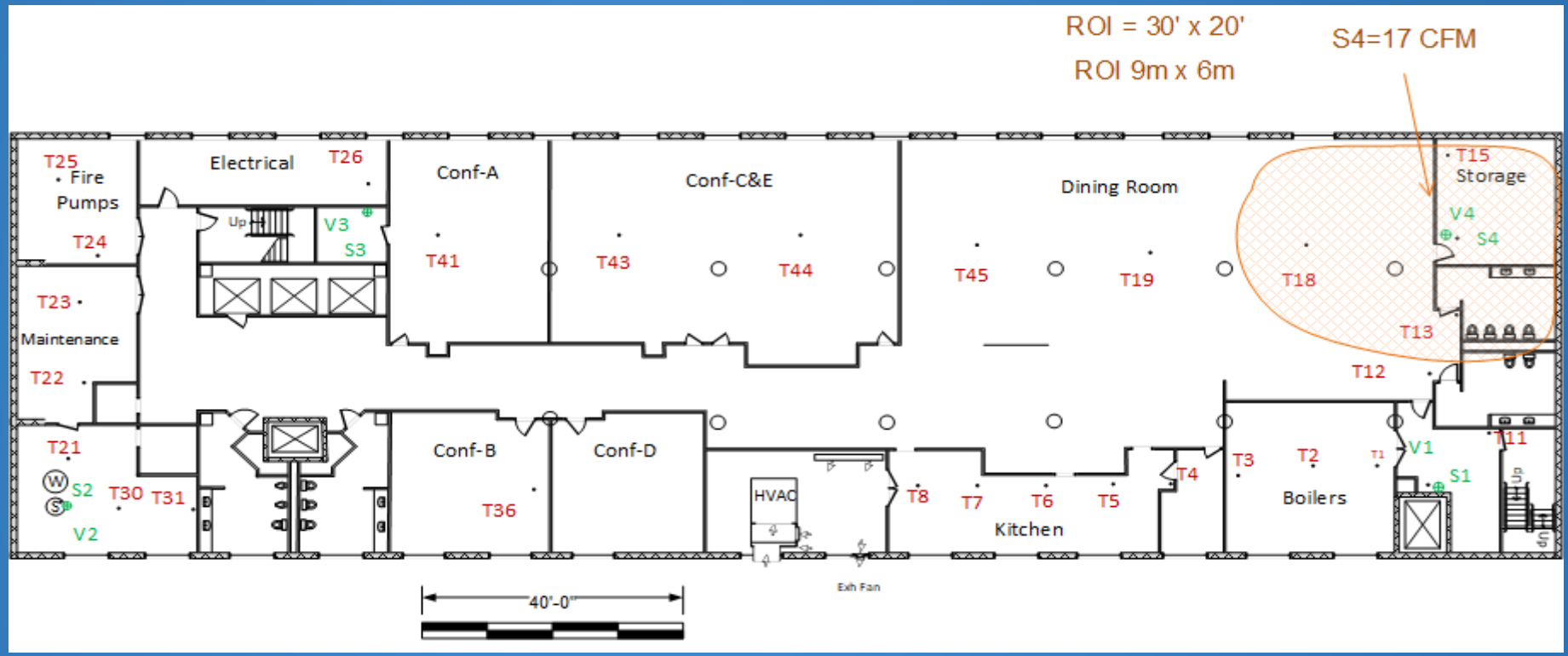
Case Study
S4 PFE

Airflow only
17 CFM

Baseline SP
11.6”

S4 20 X 30 ft ROI = 600 ft² @ 17 CFM
S3 30 X 70 ft ROI = 2100 ft² @ 55 CFM
S2 at 40 X 210 ft ROI = 8400 ft² @ 162 CFM

S4
14 X more
Sq Ft



S4 PFE did not reach across Dining Room

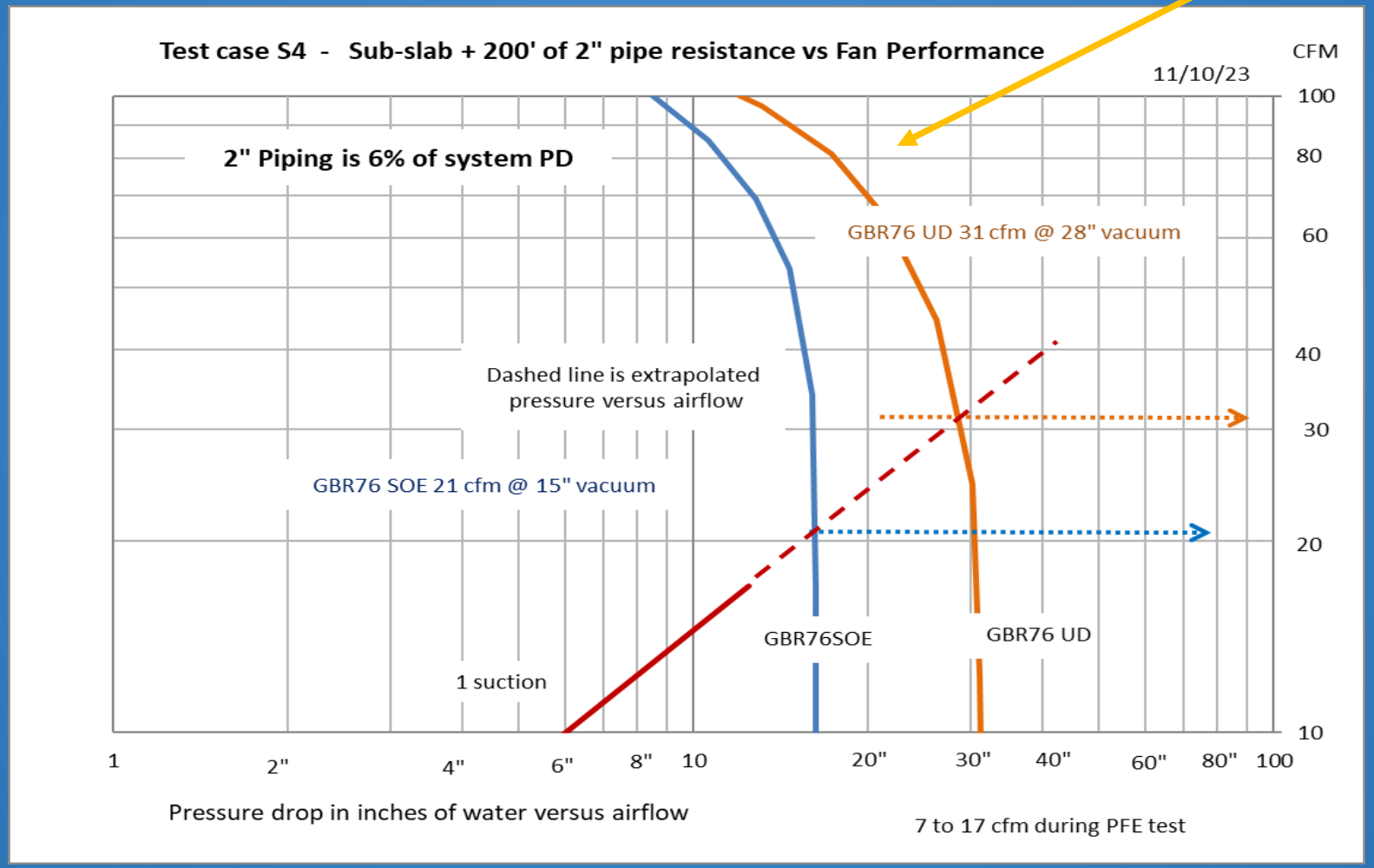
Case Study S4 PFE

200 ft 3” pipe = 0.2” SP

200 ft 2” = 0.8” SP

High Vacuum GBR76 UD best choice

2” Piping is only 6% of Total System airflow resistance



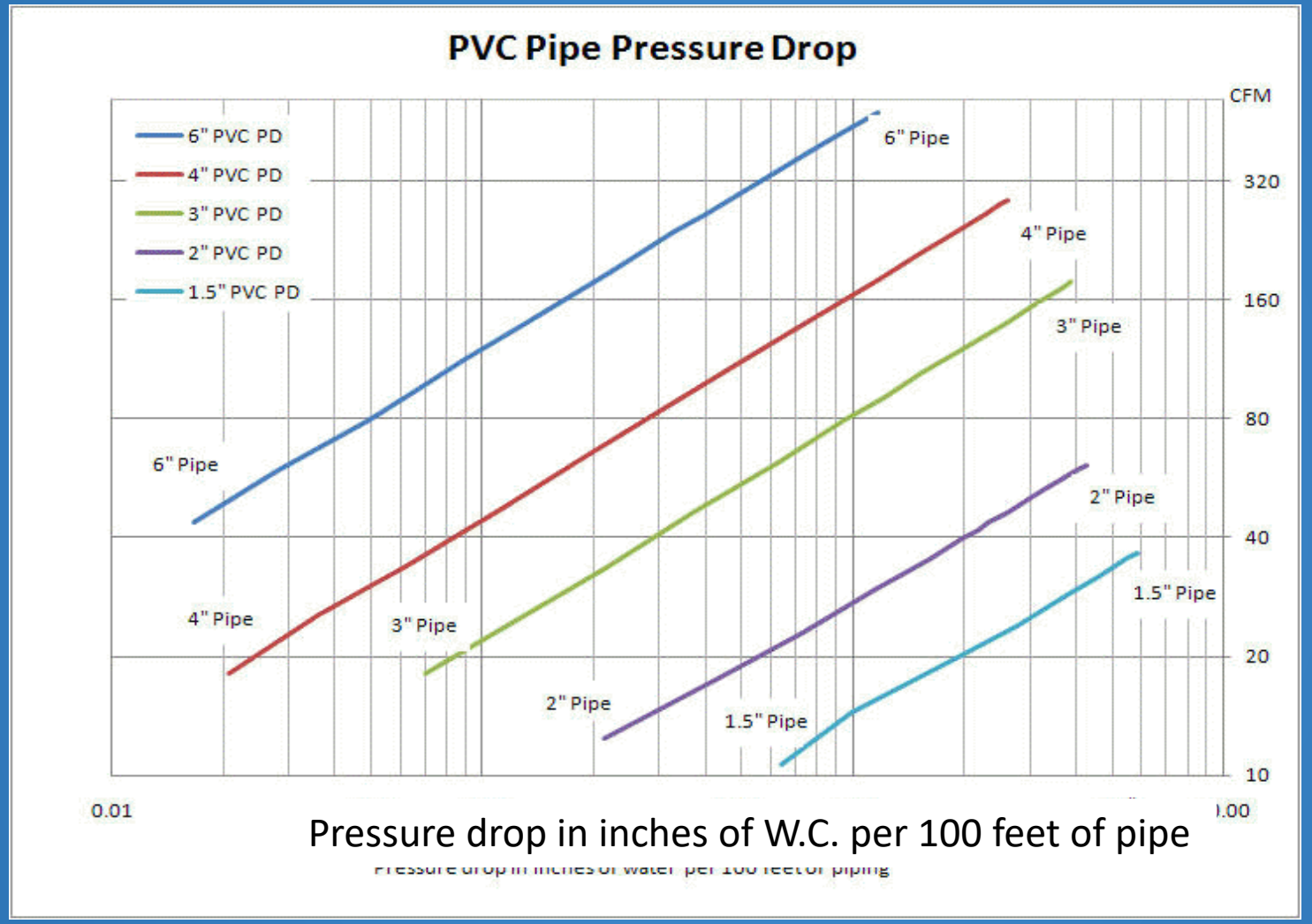
Fan speed is adjustable

Recommended Suction Pit Trenching

Increase Airflow

Piping Pressure Drop = +((0.205 * CFM * Pipe inch size ^1.7) ^-2.5) * (Total EF/100)

Critical to Calculate Piping Pressure Drop



Derived from 30 & 60 foot lengths of piping tested

Piping Pressure Drop Formula & chart at www.WPB-radon.com

Critical to add equivalent feet for all fittings used

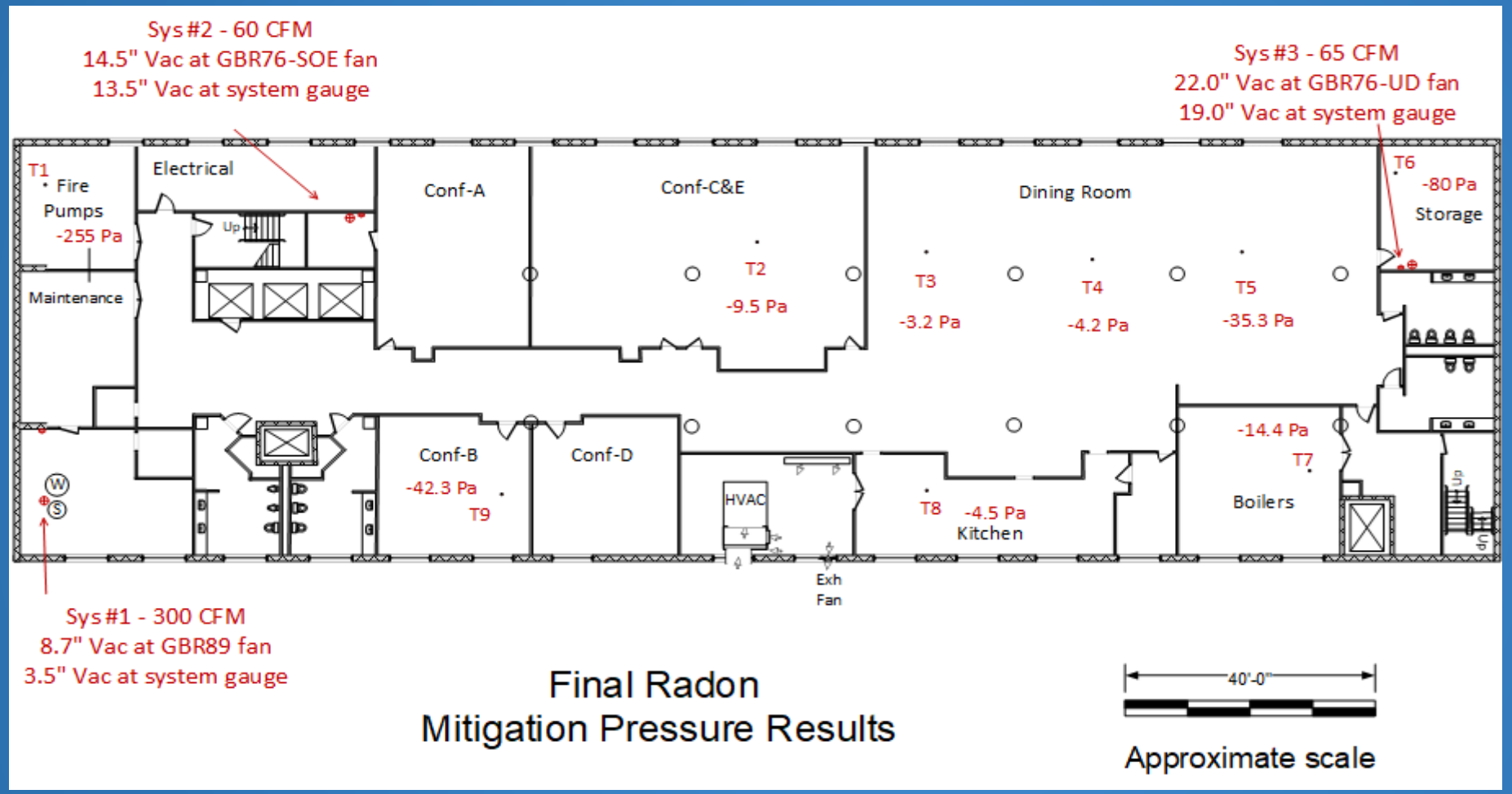
Fitting EF from 20’ of Piping

Pipe Size	Sweep 90°	Hard 90°	Sweep 45°	Angled 45°	Pipe Reducer	Open Inlet
2”	3’		2’			6.5’
3”	5’	14’	2’	4’	23’	21’
4”	6’	20’	3’	6’	16’	28’
6”	15’	26’	7’	11’	52’	40’

Angled Turn elbows have twice the pressure drop of sweeps

Formula for each fitting Equivalent Feet at CFM flow in Pressure Drop Paper

System #1 & #2 performance equaled PFE test at S2 & S3



S4 PFE predicted 32 CFM

System #3 had 65 CFM because of trenching

Least sub-slab vacuum was - 3.2 Pa or - 0.013”

Conference Papers on

Commercial PFE Testing
Calculating Piping Pressure Drop
Onsite Radon in Water Measurements
Elevation Influence

Available at:

www.wpb-radon.com

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