

SOIL GAS ENTRY RELATIVE TO
NATURAL & MECHANICALLY
INDUCED *NEGATIVE PRESSURE*
IN A LARGE BUILDING.

G HODGDEN 2023

ABSTRACT

- **THIS STUDY IS BASED DIAGNOSTIC TESTING WITH MULTIPLE RADON CRMs AND AIR PRESSURE MEASUREMENTS DURING BOTH SUMMER AND WINTER WITHIN A PORTION OF A 15-STORY STRUCTURE.**

THESE CASE STUDY RESULTS:

- ILLUSTRATE HOW SOIL GAS ENTRY IS IMPACTED DIURNALLY AND SEASONALLY, NOT ONLY BY FLUCTUATIONS IN STACK-EFFECT BUT ALSO **HVAC** INDUCED NEGATIVE PRESSURE.
- EXEMPLIFY THE DEGREE TO WHICH THE VOLUMETRIC ENTRY OF SOIL GAS CONTAINING RADON OR CHEMICAL VAPORS CAN BE IMPACTED BY CHANGES IN BUILDING OPERATIONAL CONDITIONS.

THE BUILDING

- **A COMPLEX OF JOINED BUILDING STRUCTURES SPREAD ACROSS ABOUT 12 ACRES.**
- **CONSTRUCTION PRACTICES FOR THIS NEWER BUILDING LEFT VERY FEW GAPS OR OPENINGS UNSEALED IN FLOORS AND WALLS**



THE BUILDING

- ONLY 20,000 SQ. FT. TESTED HIGH (> 4.0 pCi/L)

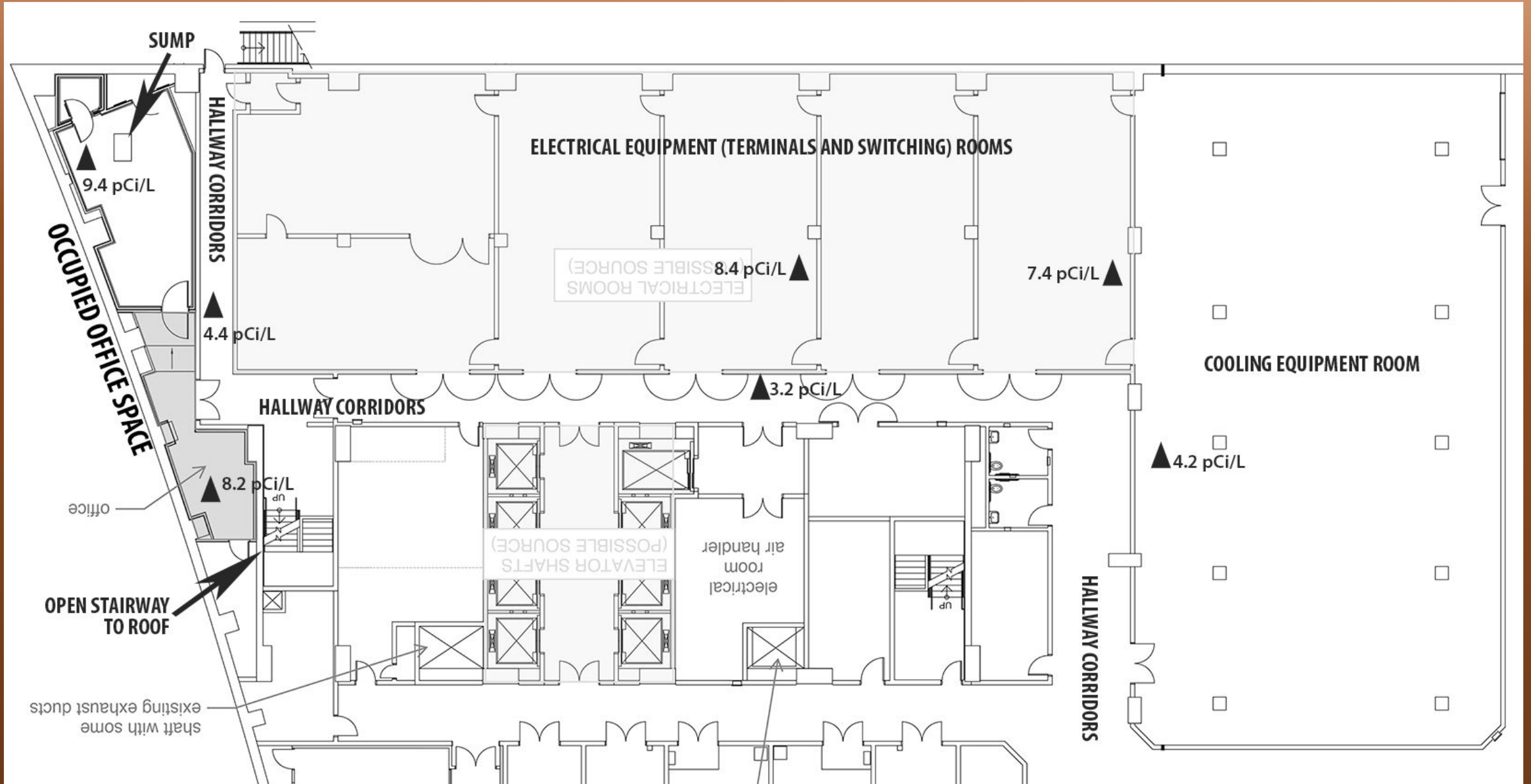


INITIAL INVESTIGATION

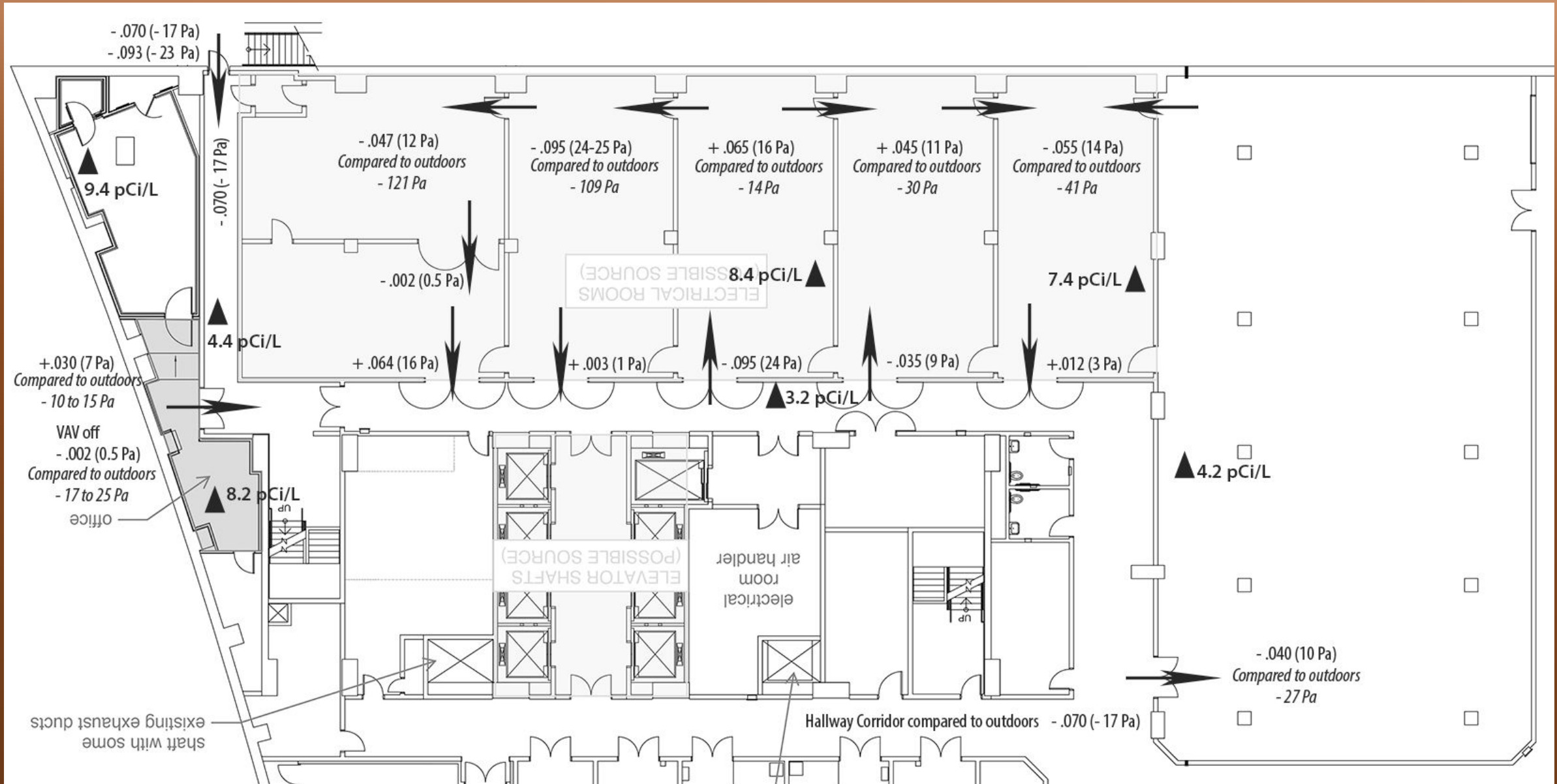
- **P**RESSURE MEASUREMENTS WERE TAKEN WITH A MICRO-MANOMETER BETWEEN MULTIPLE ROOMS AND THE VAST INDOOR CORRIDOR AIRSPACE RELATIVE TO OUTDOORS.
- **S**EVEN **C**RM**S** WERE DEPLOYED FOR FOUR DAYS. **O**UTDOOR TEMPERATURES RANGED BETWEEN **73°** AT NIGHT TO **90° F** AT MID-DAY.
- **W**E REQUESTED TO DEACTIVATE ONE **HVAC** UNIT DURING THE **4TH** TEST DAY, DUE TO PRESSURE OBSERVATIONS.

RADON MEASUREMENTS (2 DAY AVG)

• SIMILAR TO PREVIOUS TESTS

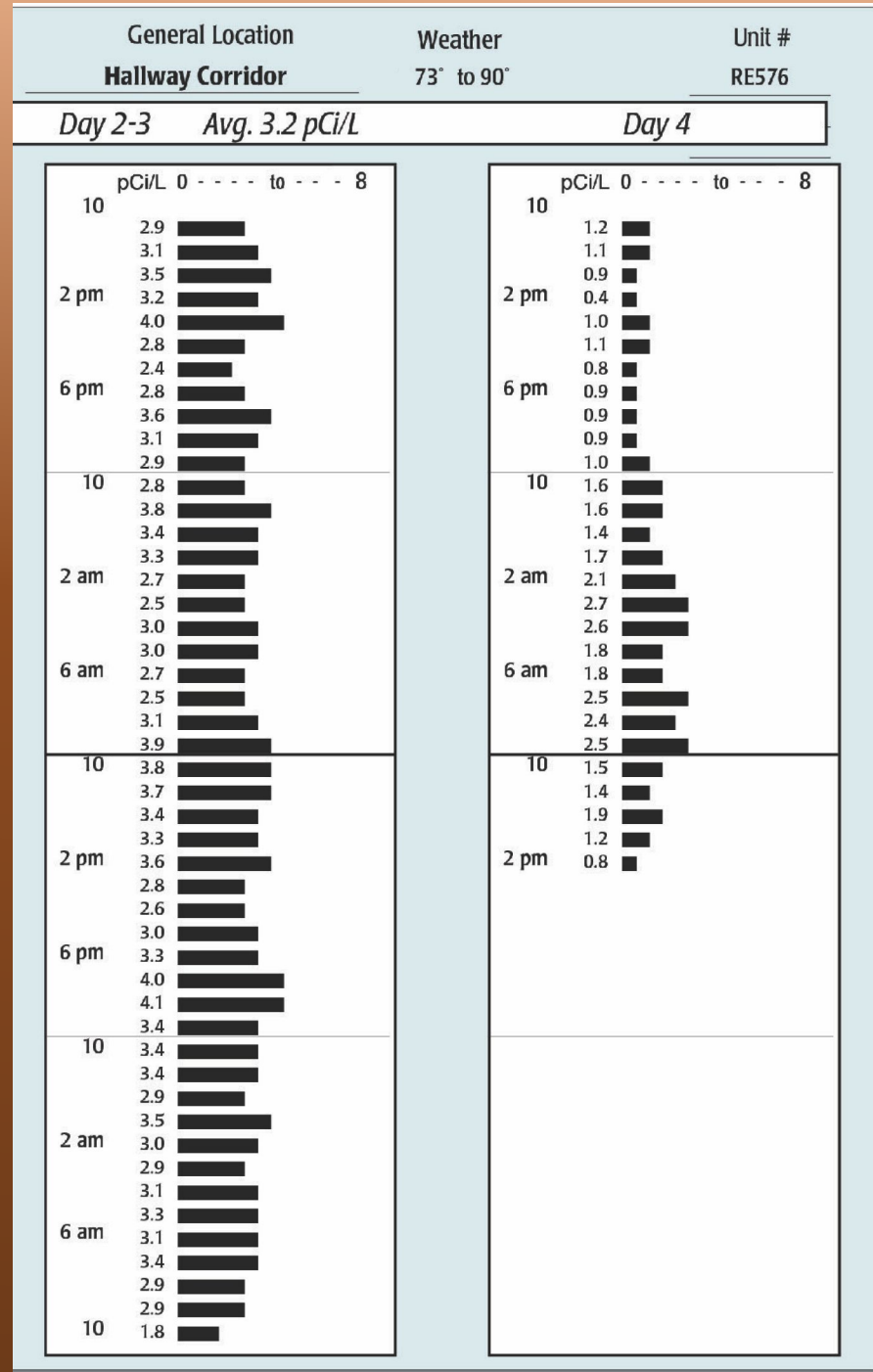
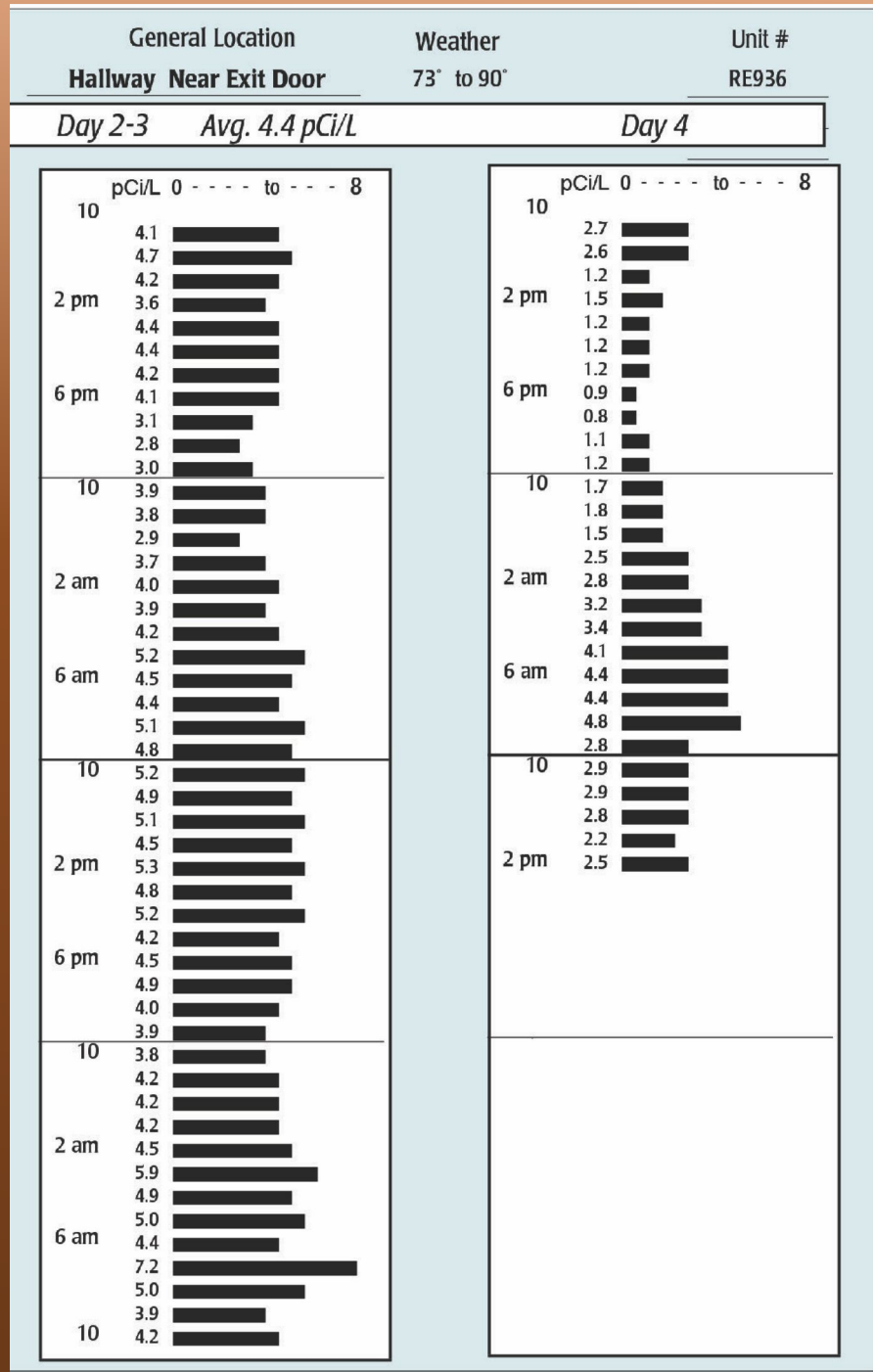


PRESSURE RELATIONSHIPS (9 ENCLOSED SPACES, HALLWAYS AND OUTDOORS)



HALLWAYS

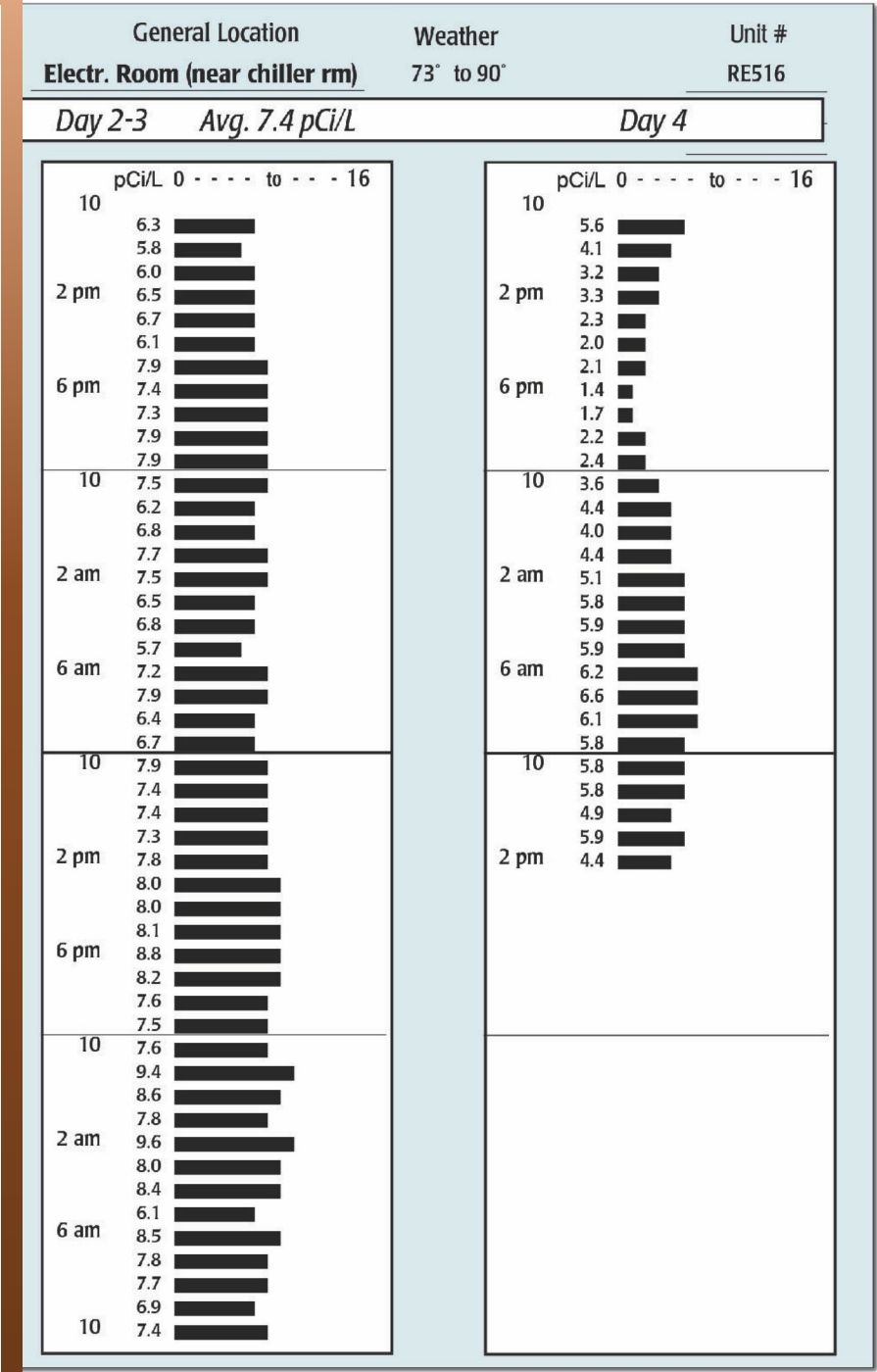
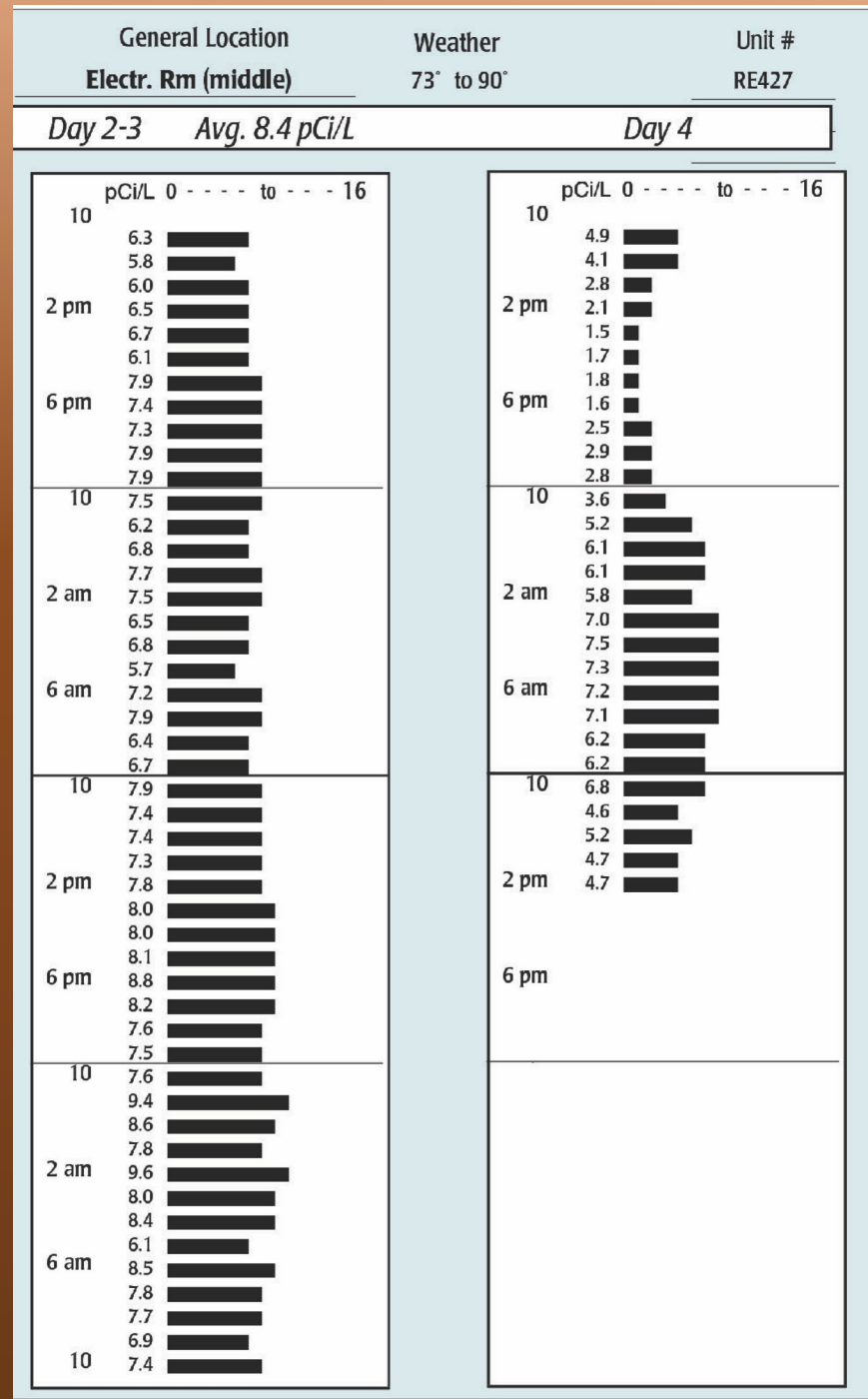
BLOWERS ON BLOWERS OFF



UNFINISHED ELECTRICAL BUS ROOMS

BLOWERS ON
BLOWERS OFF

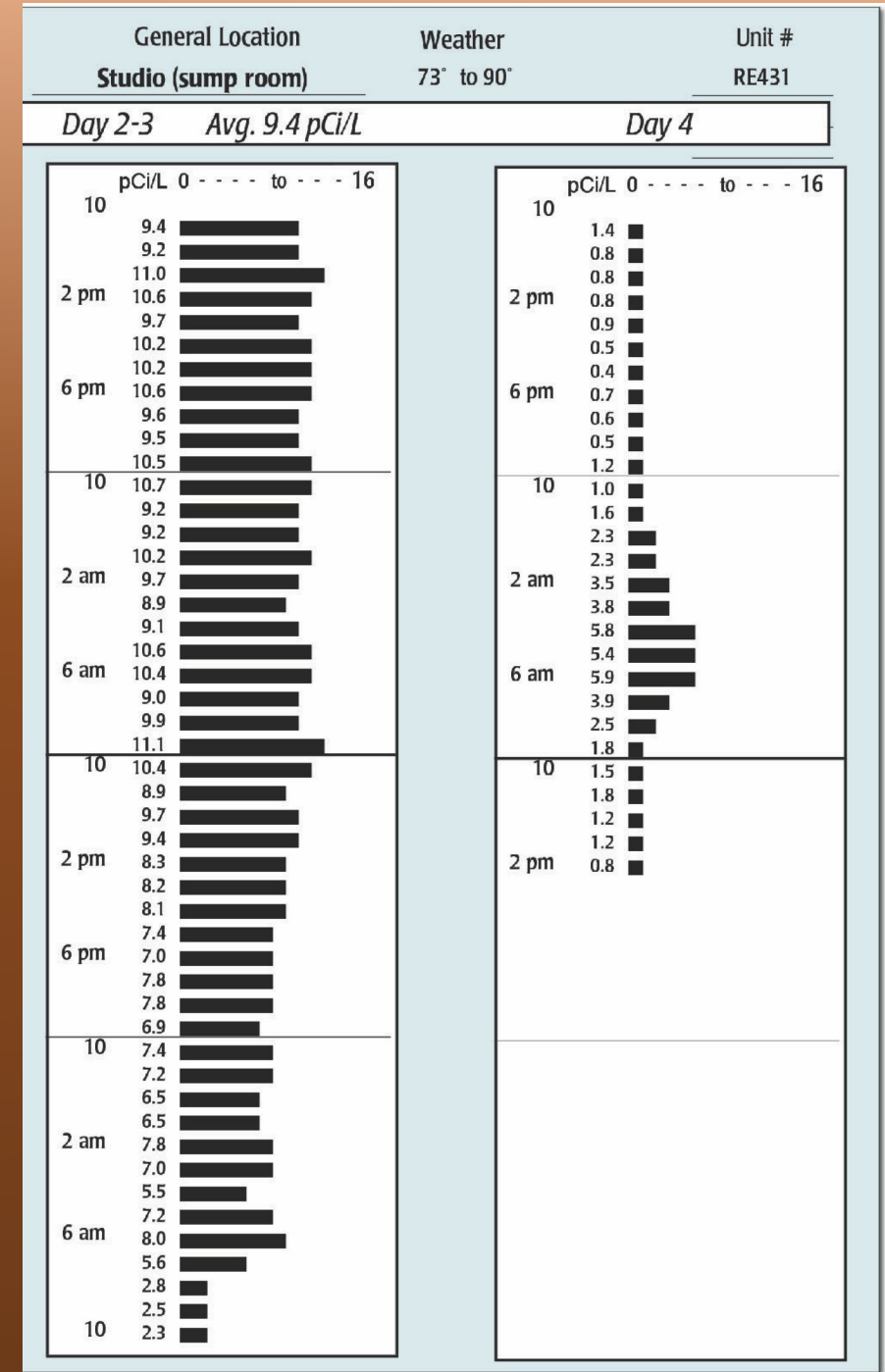
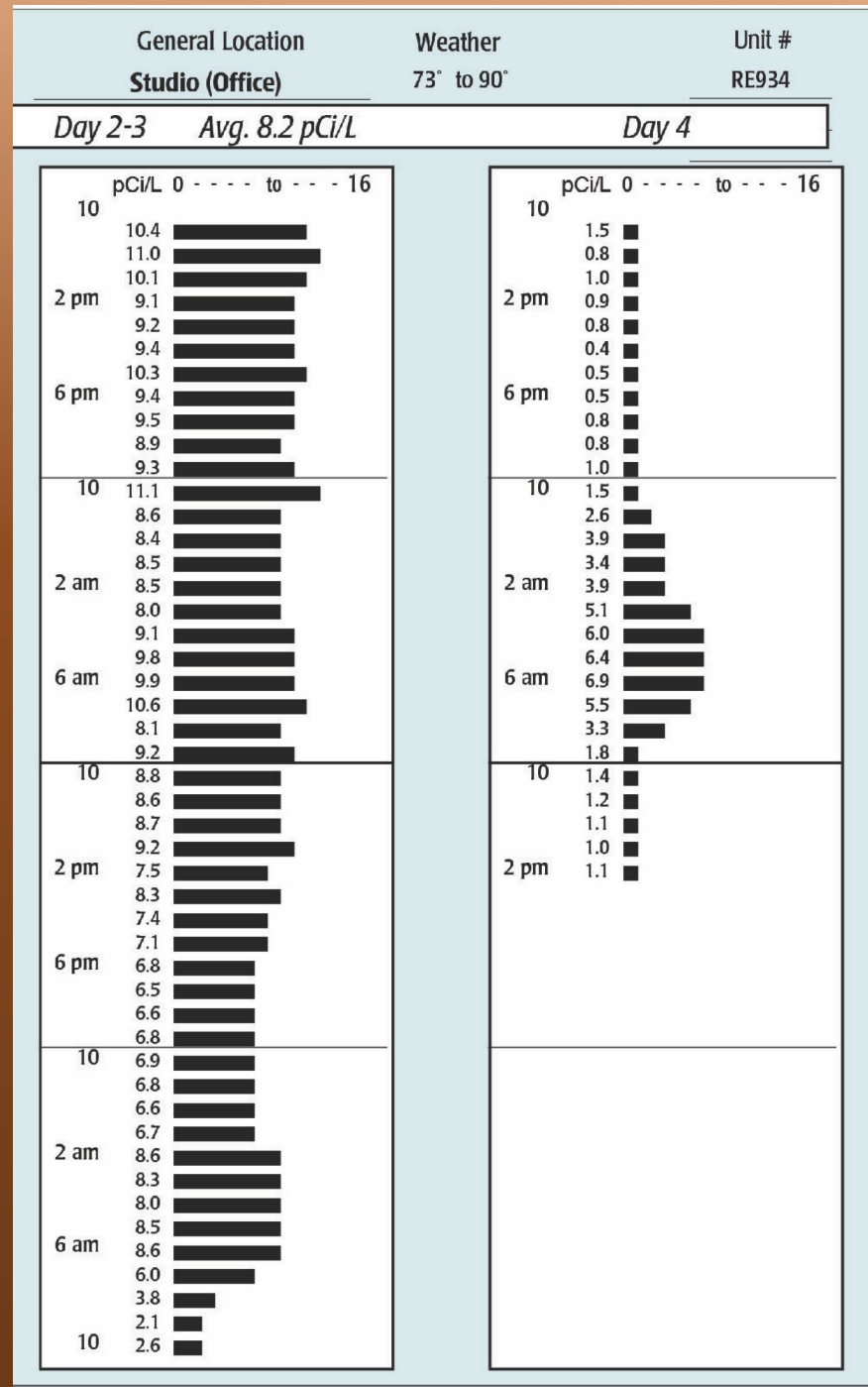
NO VENTILATION.
SLOW TO DILUTE
AND QUICK TO
RECOVER.



OCCUPIED
OFFICE

BLOWERS ON
BLOWERS OFF

DIFFERENT
HVAC ZONE:
QUICK TO
DILUTE AND
SLOW TO
RECOVER.



MITIGATION EFFORT (DIAGNOSTIC)

- **BUILDING ENGINEERS DROPPED THE AIR HANDLER RESPONSIBLE FOR THE ENHANCED NEGATIVE PRESSURE TO 60% OF ITS PREVIOUS AIRFLOW SETTINGS.**
- **THEY MODIFIED THE EXISTING VAV AIR HANDLING UNIT FOR THE OCCUPIED OFFICE ROOMS TO PROVIDE CONSTANT SUPPLY AIR WITH AN INCREASED OUTDOOR AIR PERCENTAGE.**
- **THEY ALSO MADE A TIGHTLY CLOSED SUMP TO BE AIRTIGHT.**

POST-MITIGATION INVESTIGATION

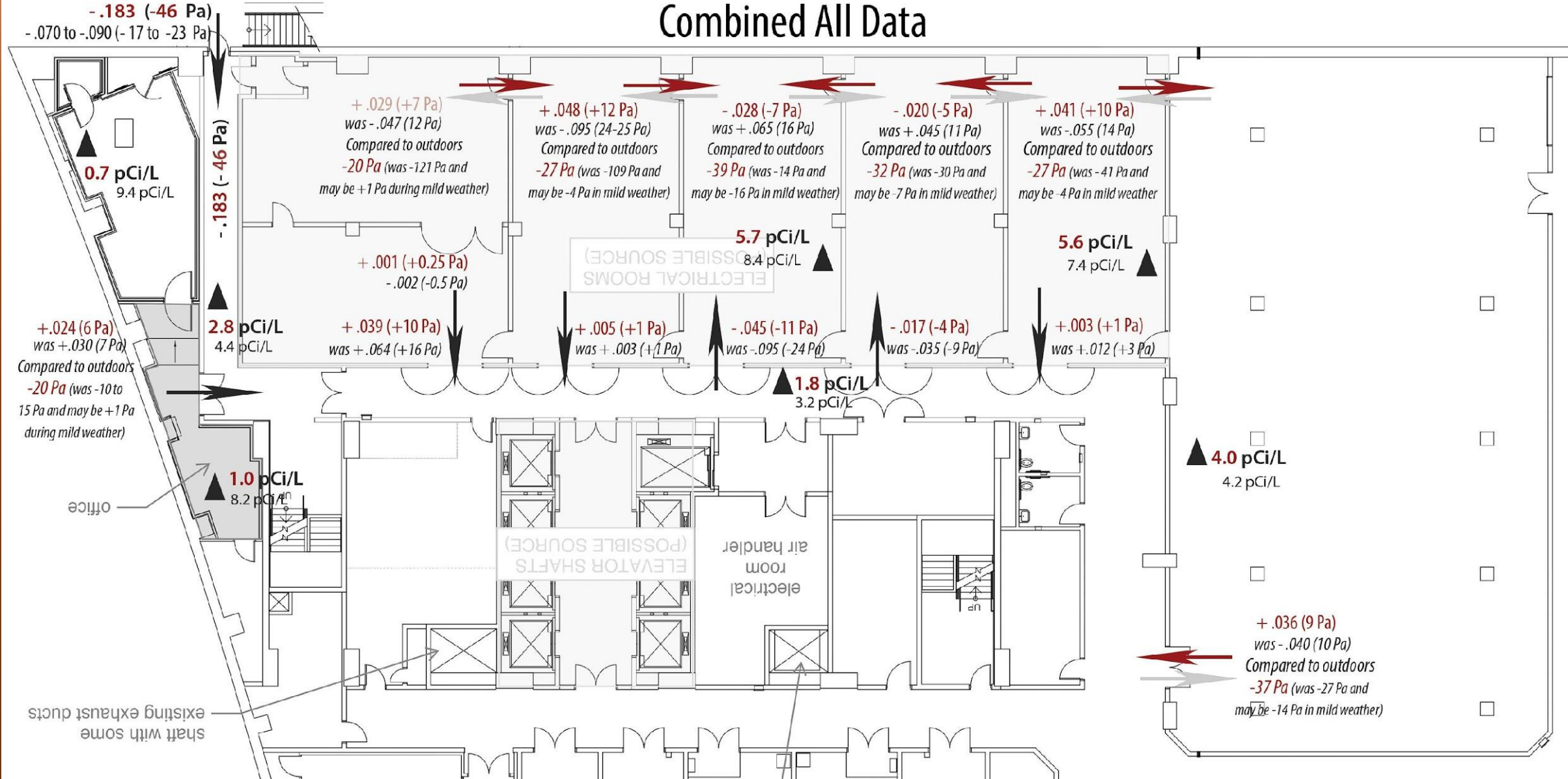
- **OUTDOOR TEMPERATURES RANGED BETWEEN 27° AT NIGHT TO 54° F ACROSS THE TEST PERIOD.**
- **RADON CONCENTRATIONS IN THE OCCUPIED STUDIO/OFFICE AREAS INDICATED 1.0 AND 0.7 pCi/L.**
- **TEST RESULTS INDICATED 2.8 pCi/L IN THE HALLWAY NEAR THE EXIT AND 1.8 pCi/L IN THE HALLWAY ADJOINING**
- **ELECTRICAL ROOMS WERE 4.0 AND 5.7 pCi/L**
- **HOURLY DATA INDICATED VERY LITTLE FLUCTUATION**

POST-MITIGATION INVESTIGATION

- **NOTEWORTHY BECAUSE INDOOR HALLWAY PRESSURES RELATIVE TO OUTDOOR AIR HAD DOUBLED FROM -23 TO -46 PASCAL (PA) RELATIVE TO MILD/HOT JULY COMPARED TO COOL/COLD FEBRUARY.**
- **HOWEVER, ONE ROOM WAS INITIALLY RECEIVING 86 PA NEGATIVE PRESSURE SOLELY DUE TO HVAC DESIGN.**
- **PRESSURE RELATIONSHIPS REVERSED FOR MANY ROOMS AFTER CHANGING SETTINGS ON ONLY ONE AIR HANDLER.**

PRESSURE RELATIONSHIPS (POST-MITIGATION)

Combined All Data



DISCUSSION-CONCLUSIONS

- **THESE RESULTS HELP ILLUSTRATE HOW THE VOLUME OF SOIL GAS ENTRY IS DRAMATICALLY IMPACTED BY CHANGES IN BUILDING OPERATING CONDITIONS.**
- **DUE TO METICULOUS CONSTRUCTION PRACTICES, THEY ALSO HELP ILLUSTRATE THAT THIS OCCURS WITHOUT A TRADITIONAL PREFERENTIAL PATHWAY.**

DISCUSSION-CONCLUSIONS

- **INHERENT TO VIRTUALLY ALL LARGE BUILDING HVAC DESIGNS, NEGATIVE PRESSURE IS USED AS INEXPENSIVE WAY TO CONTROL THE DESTINATION OF ODORS AND SOMEWHAT INCREASE AIR EXCHANGE RATES TO MITIGATE INDOOR AIR POLLUTANTS.**
- **A BATHROOM FAN MAY BE THE SIMPLEST EXAMPLE.**

DISCUSSION-CONCLUSIONS

- **BUT IN LARGER BUILDINGS, THE TRADITION FOR HVAC DESIGNS TO LIBERALLY OVERSIZE THE USE OF NEGATIVE PRESSURE IS WIDELY WITNESSED TO DRAMATICALLY INCREASE SOIL GAS ENTRY INTO BUILDINGS.**
- **THESE RESULTS ALSO HELP TO UNDERSTAND HOW THE USE OF HVAC SETBACK FOR SAVING ENERGY COSTS AT NIGHTS AND WEEKENDS CAN DRAMATICALLY CHANGE THE DYNAMICS OF SOIL GAS ENTRY RATES AND AIR EXCHANGE (DILUTION) RATES FROM DAY COMPARED TO NIGHT.**

IN CLOSING

- **FEW (ASD) SYSTEMS COULD EVER COMPETE WITH THESE LARGE AIR HANDLERS.....**
- **UNLESS SOMETHING IS DONE TO REDUCE AIR HANDLER INFLUENCE.**



Questions?