

Bennington State Office Building TBS Diagnostic Results Summary

Steven M. Caulfield, P.E., CIH

08-02-07

William A. Turner, M.S., P.E.

Turner Building Science & Design, LLC

www: turnerbuildingscience.com
1-800-439-3446

Copyright Turner Building Science & Design, LLC 2007

1

Scope: Diagnostics & Corrective Action Recommendations (C.A.R.)

- Assist The State of Vermont Dept. of BGS and VDOH as needed, Collaborate w. NIOSH
 - Reviewed History
 - Evaluated Twenty Three Different Parameters
 - | Five Common Routine Measurements (*Routine*)
 - | Plus Nineteen Diagnostic Type Evaluations (*Diag.*)
- NIOSH loaned equipment & funded additional diagnostic testing

Copyright Turner Building Science & Design, LLC 2007

2

Executive Briefing (very short)

- **Results:** Only two main observations that make this building stand out as different from many others that commonly exist that could be related to elevated disease.
- #1, Boiler Soot is deposited throughout the facility.
- #2, Multiple Microbial Reservoirs exist (over 90) with multiple dissemination pathways.

TBS is recommending thirteen corrective action to date.

RESULTS

**By Report Sections:
3.1- 3.16**

**First: Boiler Soot &
Microbial Reservoirs**

3.10 Deposited Black Stain Assessment (Lab Analysis) *Diagnostic*

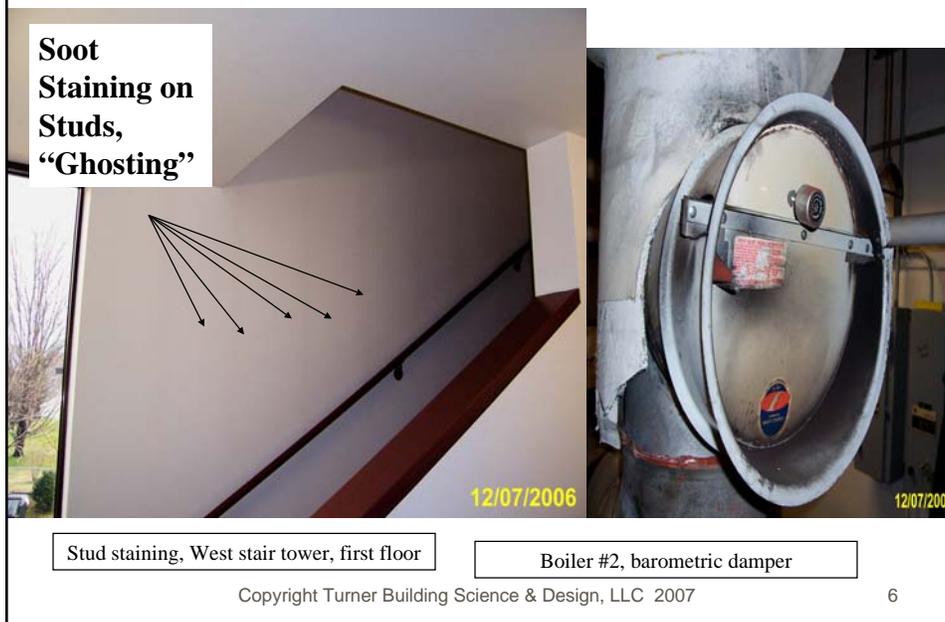
■ **Results:** Visual Staining in stairwell. Lab analysis confirmed boiler soot on air filters & deposited throughout the facility . Rather unusual finding. Calculations and Tracer confirm dissemination pathways.

■ **Info. Appendix. #B1, C4, D4**
C.A.R.: #2,#7,#4 Replace the Boiler System, Seal Gross Air Leakage, Clean The Ducts.

Copyright Turner Building Science & Design, LLC 2007

5

Staining / Soot



Copyright Turner Building Science & Design, LLC 2007

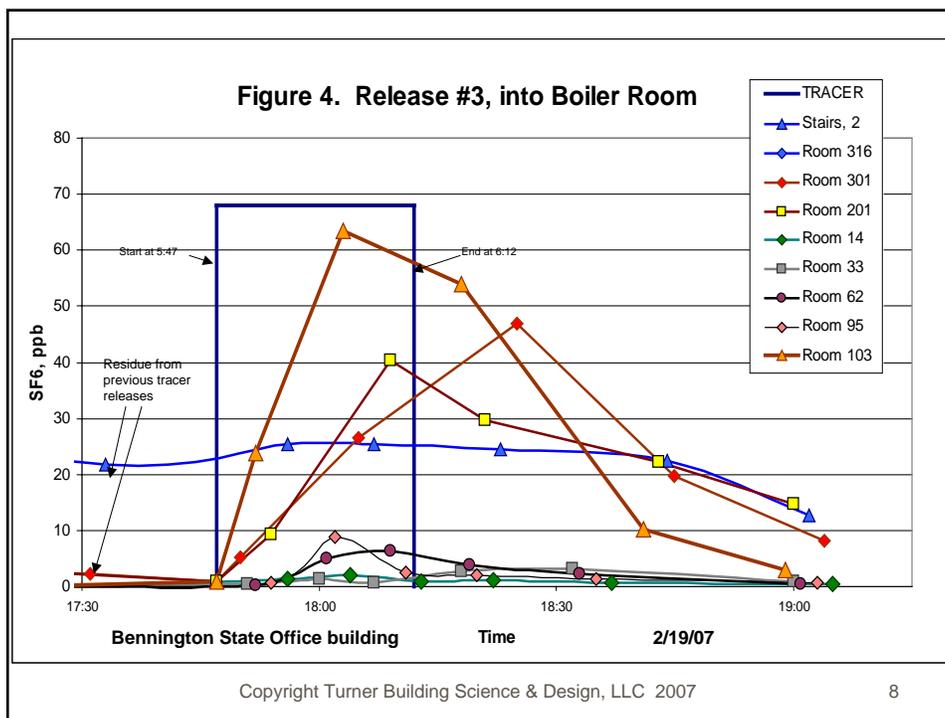
6

3.12 .2 Boiler Room Fugitive Air Evaluations (Tracer Testing) *Diagnostic*

- **Results:** Pathways confirmed, air moved into facility almost instantly, then moved to all three floors within 10 minutes.
- **Info. Appendix. #C3, Figure 4**
C.A.R.: #2, #7 Replace the boiler, seal gross air leakage.

Copyright Turner Building Science & Design, LLC 2007

7



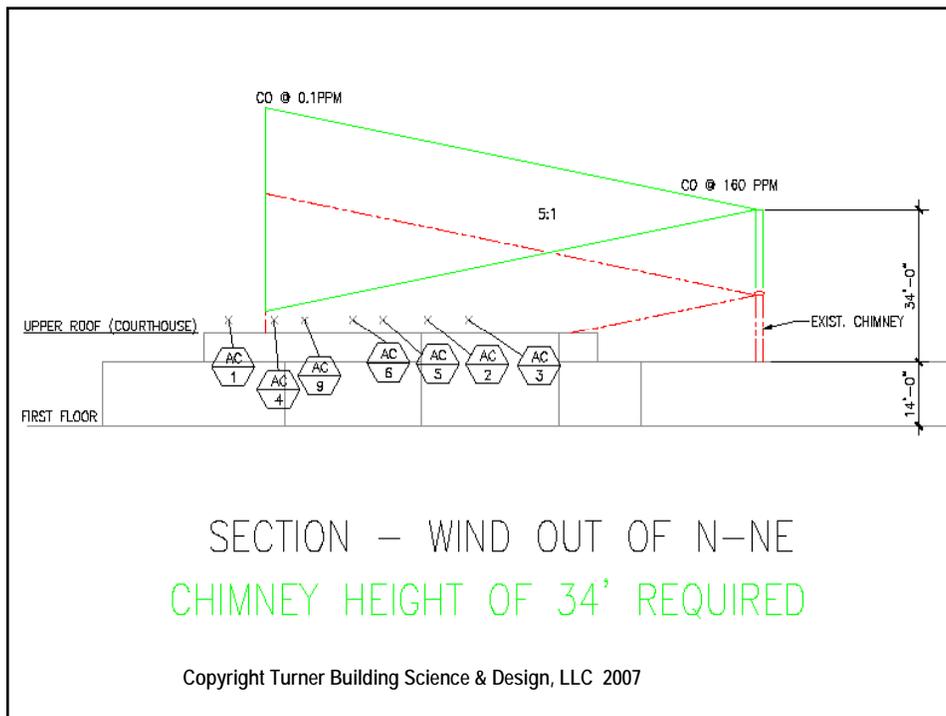
3.15 Boiler Stack Calculations

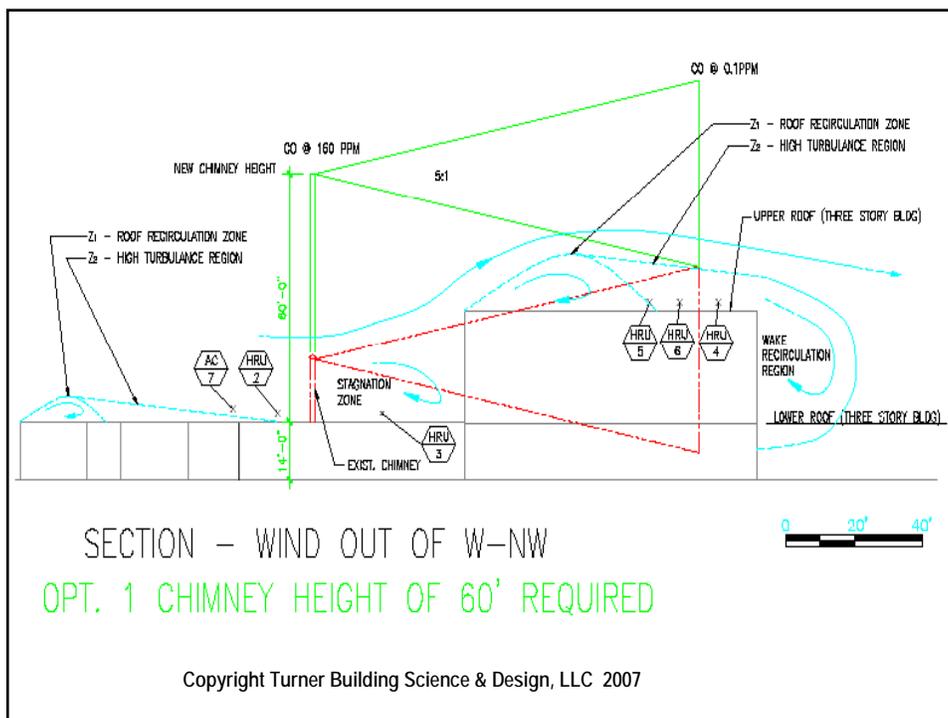
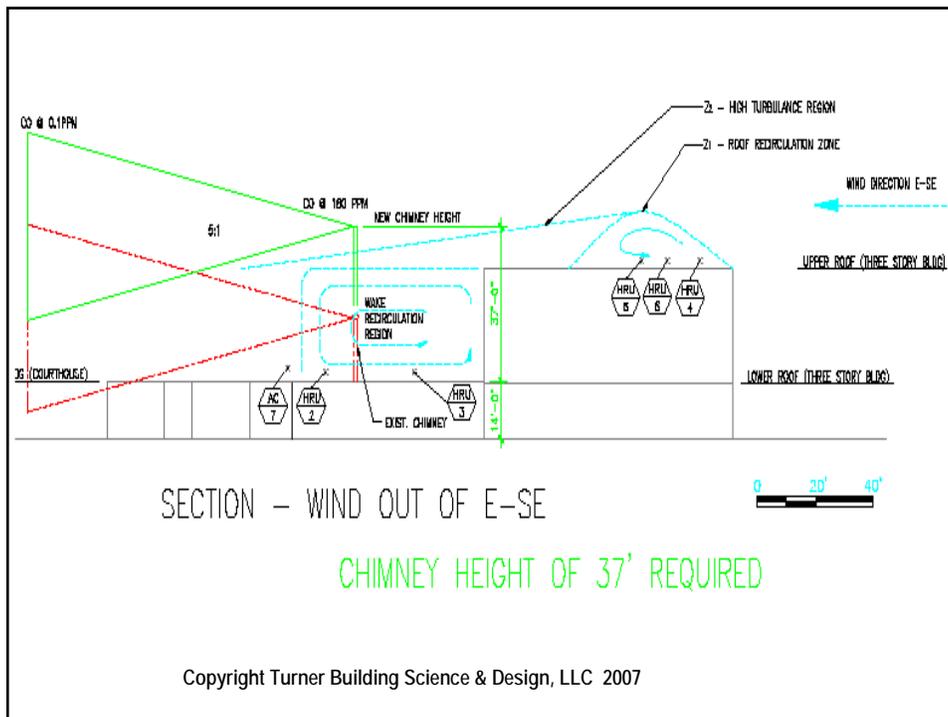
(ASHRAE calculations) *Diagnostic*

- **Results:** Current boiler stack location not suitable. Needs to discharge way above level of top floor to stop reentrainment.
- **Info. Appendix. #D4**
C.A.R.: #2, #7 Replace Boilers, Fix Gross Air Leaks.

Copyright Turner Building Science & Design, LLC 2007

9

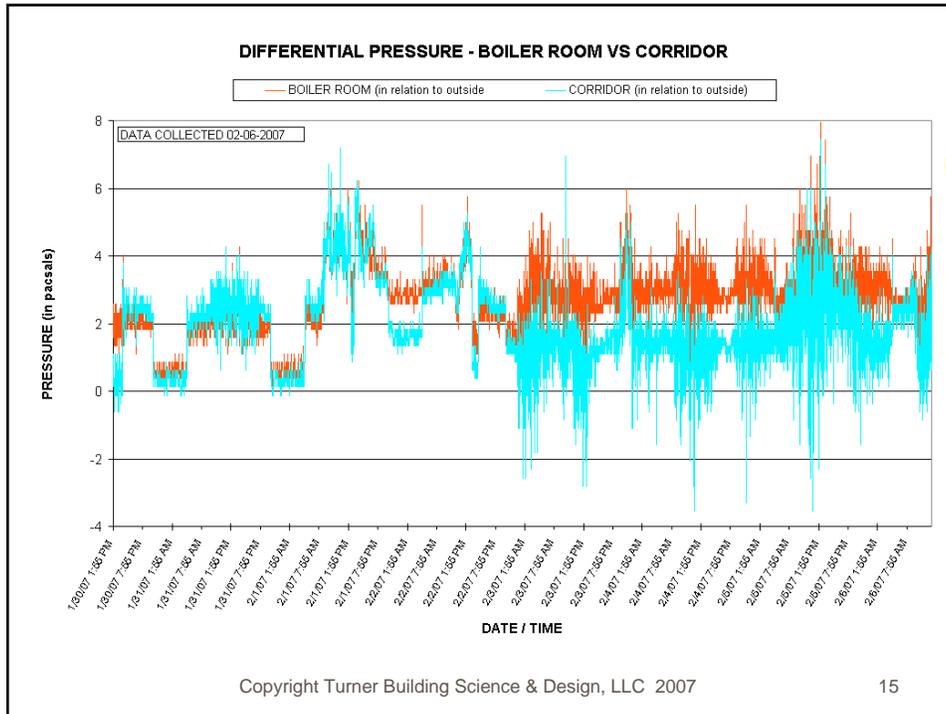




3.16 Boiler Room Pressures (Monitoring) *Diagnostic*

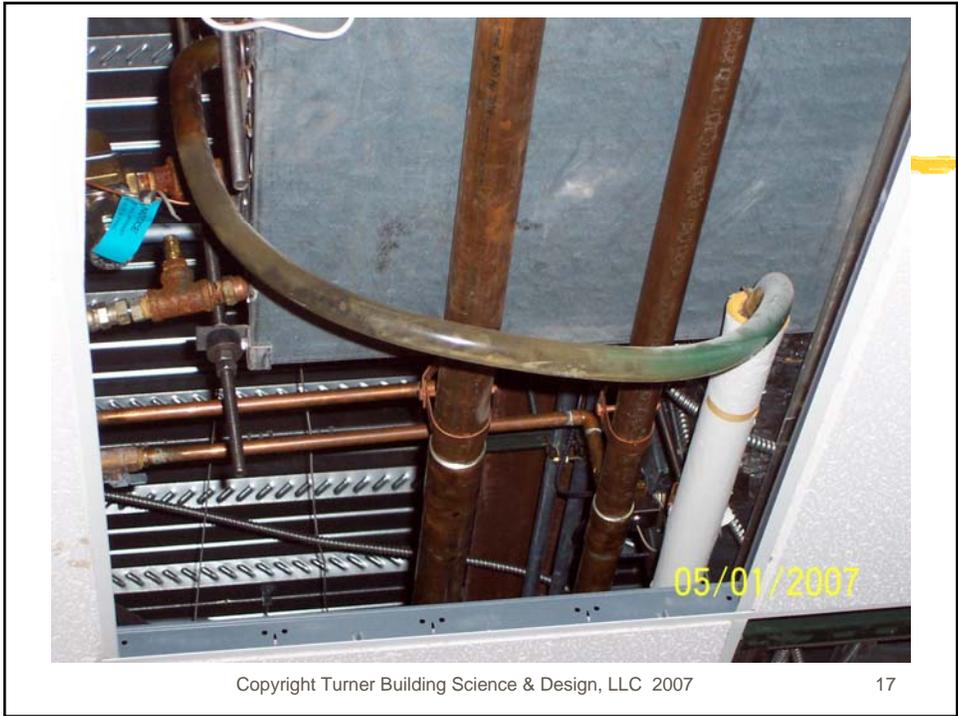
- **Results:** Current boiler room pressure in wrong direction, current make-up air controls abandoned.
- **Info. Appendix. #C4**
C.A.R.: #2, Replace Boilers, move boiler room? or computer monitor and control pressures?.





3.5 Microbial Source Sampling Assessment (spot checks) *Diagnostic*

- **Results:** Multiple reservoirs located throughout the facility, dissemination pathways exist. Sec. 3.11, 3.12, 3.13
- **Info. Appendix #B 5,6,7 C3, E4, E5**
- **C.A.R: #1 Replace the HVAC System, also #5, #6, #9 #10**



Copyright Turner Building Science & Design, LLC 2007



Copyright Turner Building Science & Design, LLC 2007

3.12 .3 Condensate Drain Line Fugitive Air (Tracer Testing) *Diagnostic*

- **Results:** Multiple pathways confirmed, air moved into facility almost instantly in both drain lines tested 3rd and 2nd floor, then moved to other two upper floors within 20 minutes.
- **Info. Appendix. #C3, Figure 1,2,3**
C.A.R.: #1, #10 Replace the HVAC Systems, clean the facility.

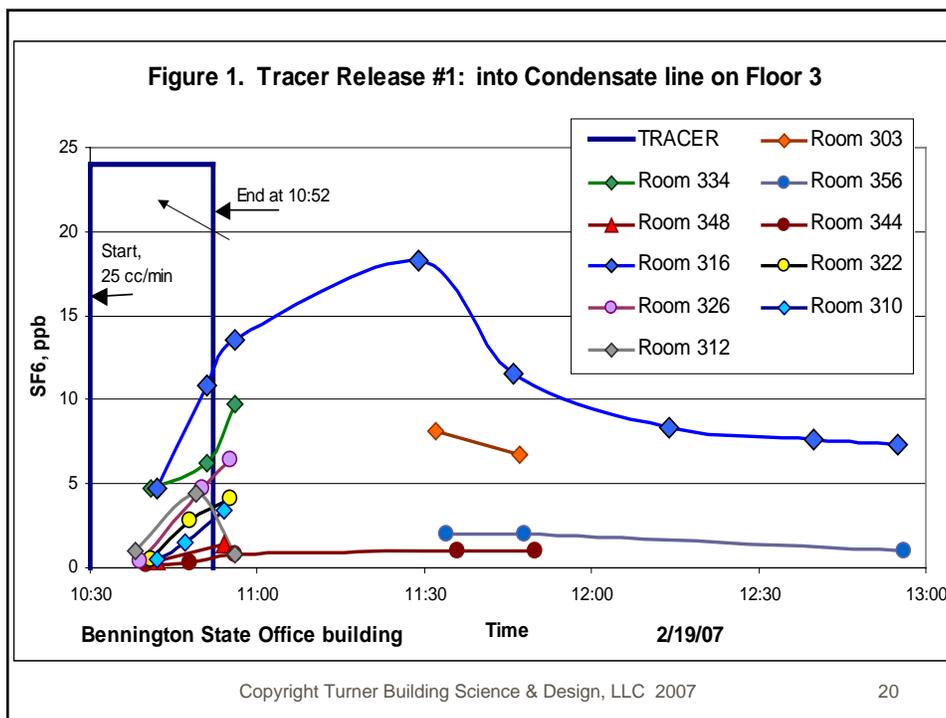


Figure 2. Tracer release #1 into Condensate Line on Floor 3

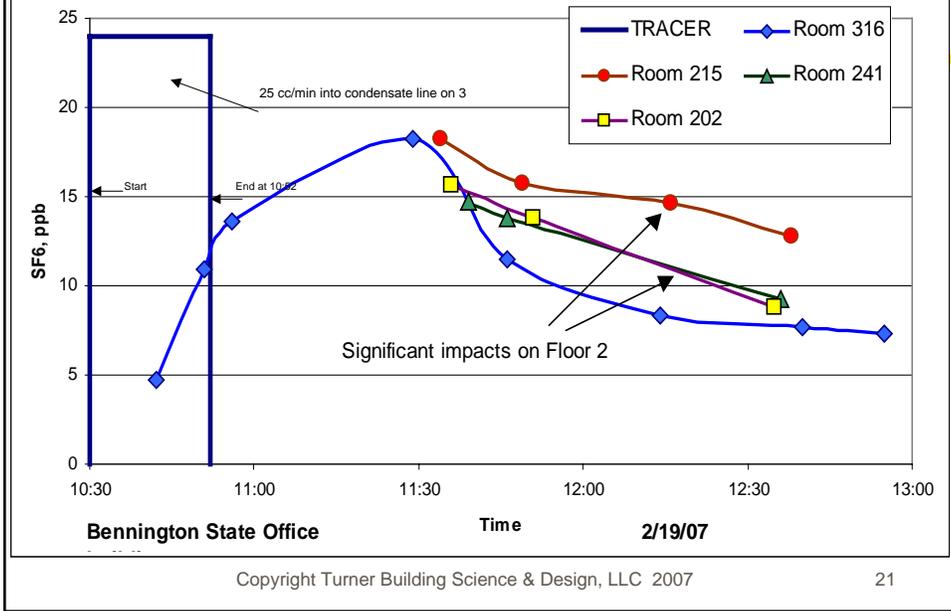
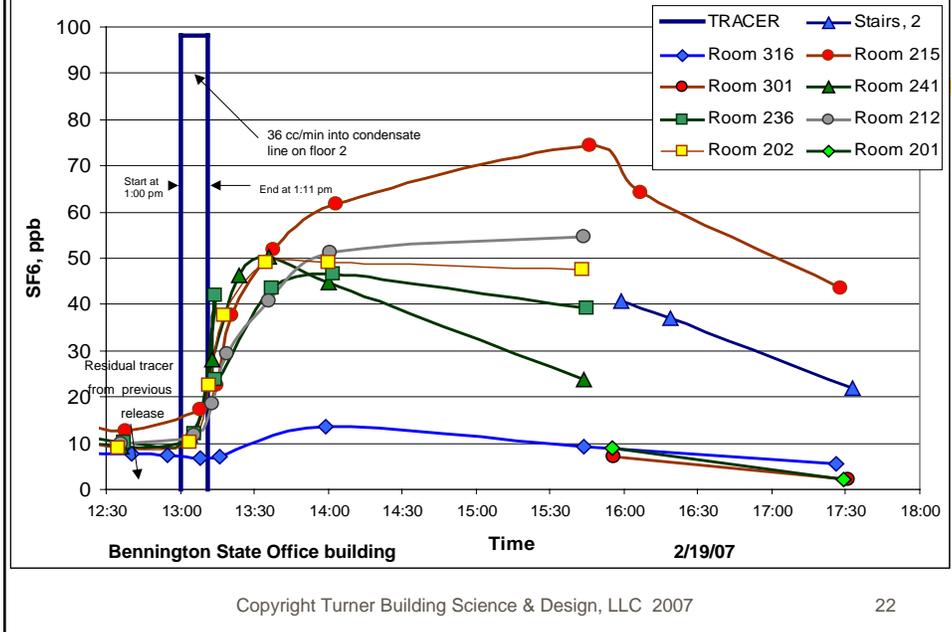
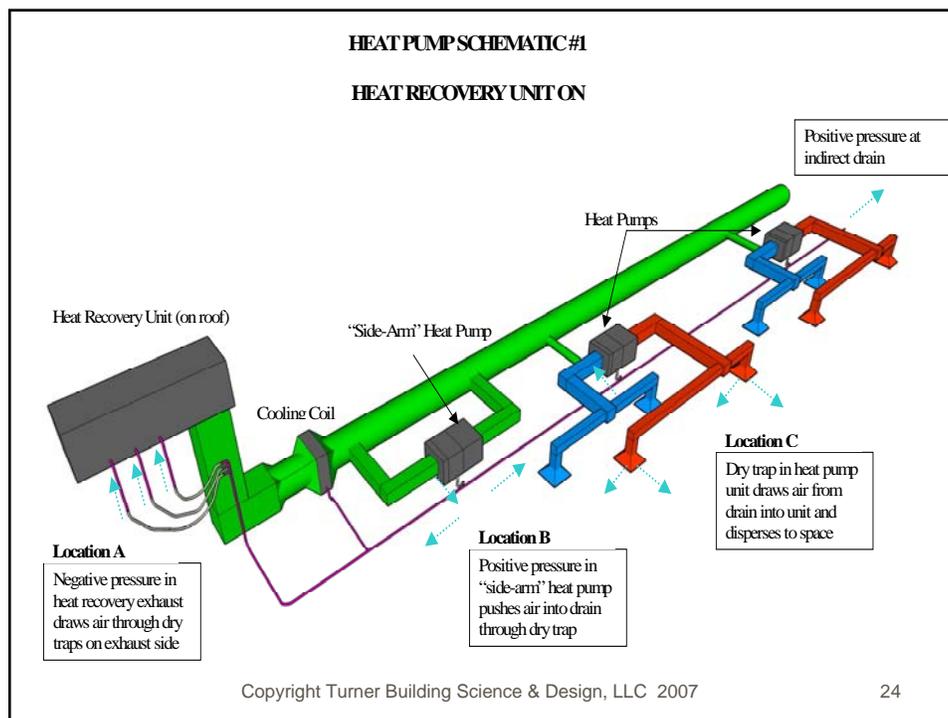


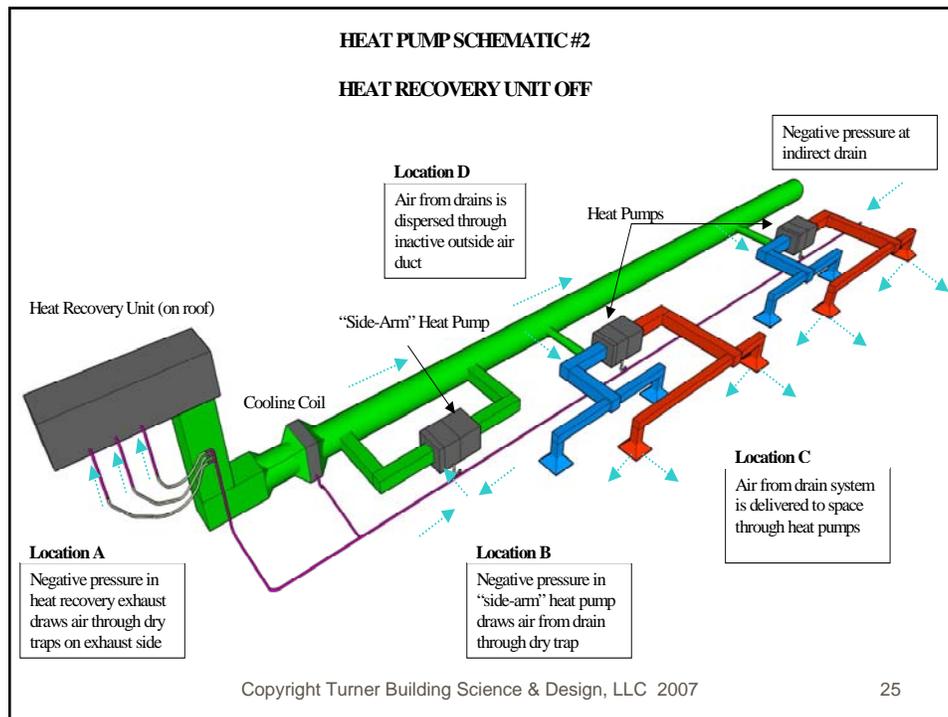
Figure 3. Tracer Release #2, into Condensate Line on Floor 2



3.13 Condensate Drain Aerosolization (Mapping) *Diagnostic*

- **Results:** Multiple pathways airflow mapped, three primary routes for routine microbial dissemination.
- **Info. Appendix. #D3, Schematic 1 & 2**
C.A.R.: #1, #10 Replace the HVAC Systems, clean the facility.

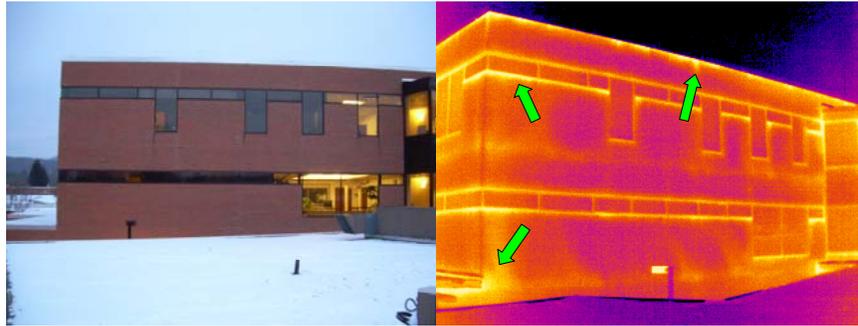




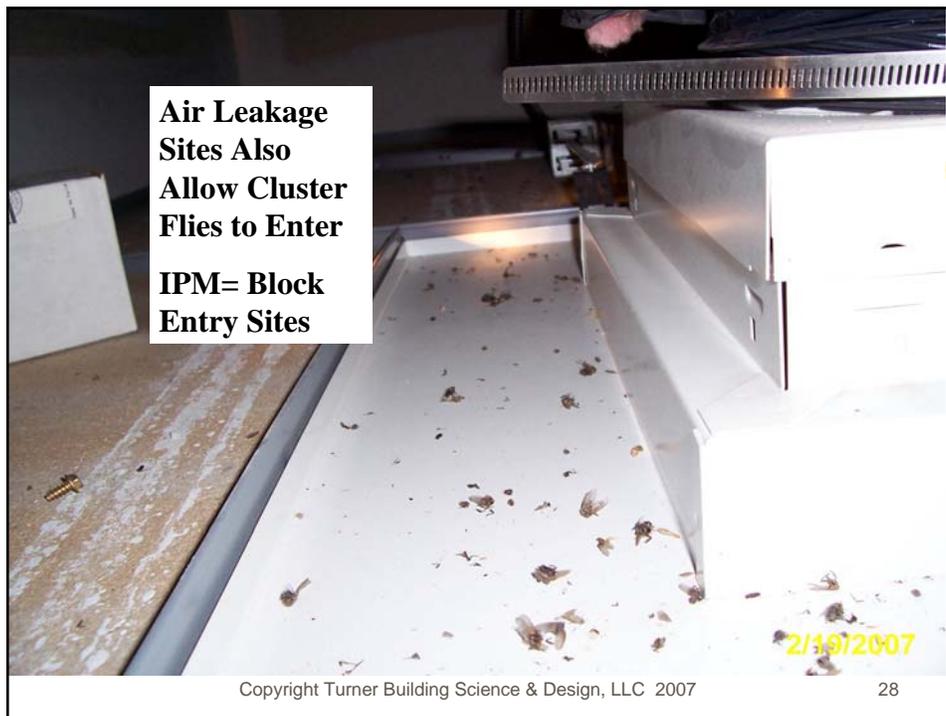
3.14 Moisture Intrusion Testing (Infrared) *Diagnostic*

- **Results:** Infrared Thermography finds lots of air leaks and suspect wet wall moisture areas.
- **Info. Appendix. #C1**
C.A.R.: #7, Professionally seal multiple gross air leakage sites, (conforms with IPM for cluster flies).

Infrared (Exterior Photo)



Example: Air Leakage Sites



3.14 Moisture Intrusion Testing (Disassembly) *Diagnostic*

- **Results:** Disassembly and moisture meter confirm some walls wet. Old facility not built as drawn Gypsum vs. CDX plywood behind brick veneer. New facility very minor issues.
- **Info. Appendix. #C6**
C.A.R.: #5,#6,#8 Rebuild (from inside)
1978 walls and windows, fix other areas
1991.

Intrusive Disassembly Photo's 1978 Building



West wall, Room 20

North wall, Room 21

Exterior - Building Wetting



Intrusive Disassembly Photo's Courthouse Section 1978 Building



South wall, Court Clerk area

South wall, Court Clerk area

Intrusive Disassembly Photo's 1991 Building (only 2 small areas)



3.14 Moisture Intrusion Testing (Floor Disassembly) *Diagnostic*

- **Results:** Disassembly of both floors confirmed vapor barriers as designed, some dampness from past flooding? Ongoing exterior wetting. New facility, only very minor issues.
- **Info. Appendix. #C7**
C.A.R.: #9 Fix exterior wetting 1978.

Concrete Slab - Hole Cutting Vapor Barriers Present As Designed



1978 Building - Room 86

1991 Building - near Room 120

Copyright Turner Building Science & Design, LLC 2007

35

3.1 Ventilation Assessment (CO2 Logging & spot checks) *Routine*

- **Results:** Carbon Dioxide levels looked normal, not high, *often too low*. Building air leakage & poor ventilation control contributes to extreme winter dryness and summer dampness.

Info. Appendix #A1, A4, A8, C1

C.A.R.: #1 Better OA Controls

#7 Prof. Seal Gross Air Leaks

#11 Reduce Excess OA Delivery

Copyright Turner Building Science & Design, LLC 2007

36

3.2 Carbon Monoxide Assessment (CO Logging & spot checks) *Routine*

- **Results:** Carbon Monoxide levels looked normal, 0-1 during monitoring. No indication of current CO hazard.

Info. Appendix #A2, A8

C.A.R.: #2 Replace the Boiler System, Should Eliminate all CO & fumes from boilers.

3.3 Temperature Control Assessment (Logging) *Routine*

- **Results:** Inconsistencies in temperature control on daily and weekly basis. Would not meet ASHRAE guidelines.

Info. Appendix #A3

C.A.R.: #1 Better Controls Recommended

3.3 Relative Humidity Assessment (Logging) *Routine*

- **Results:** Very Low RH during monitoring, 10-15% RH. VDOH should evaluate for health exacerbation concern. Would not meet ASHRAE guidelines.

Info. Appendix #A3

C.A.R.: #1,#7,#11 Better Control Recommended

- Seal Gross Air Leakage,
- Improved Outdoor Air Control,
- Enthalpy Energy Recovery?,
- RTU, Shut System off if no one in zone?.

3.4 (PM -10) Particle Assessment (Logging) *Routine*

- **Results:** Normal average levels for offices and schools compared to US EPA BASE office building study. Some spikes. Boiler impact on roof. Improve housekeeping in some areas?

■ **Info. Appendix #D4, A7**

C.A.R.: #1,#10, #13 Replace the Boiler System, Improve Housekeeping.

3.6 (Laser) Particle Assessment (Logging) *Diagnostic*

- **Results:** Normal except 1st floor rooms anywhere near boiler. Some spikes. 3.15 Calculations predict Boiler impact on roof.
- **Info. Appendix #D4**
C.A.R: #2 Replace the Boiler System, Should Eliminate all fumes from boilers.

3.7 Occupant Interviews (Specific, When Requested) *Diagnostic*

- **Results:** (TBS) Temperature control, odors, concern for health. VDOH & NIOSH did primary survey.
- **Appendix #E3 VDOH**
C.A.R: All 13 C.A.R.'s should address temp and odor concerns.

3.8 (PM -2.5 & -10) Particle Assessment (40 hr. Weekly) *Diagnostic*

- **Results:** (Lab) Normal average levels and elements for offices. Shelter from outdoor particles. Some minor impact from boilers and road salt. No elevated or strange elements.
- **Info. Appendix. #B1**
C.A.R.: #1, #10, #13 Replace the Boiler System, Improve Housekeeping.

3.9 Dry Cleaning Fluid Testing (24 hr. Lab sample) *Diagnostic*

- **Results:** Normal low levels compared to Vermont background data. No signs of impact from any local contamination.
- **Info. Appendix. #B2**
C.A.R.: None needed.

3.11 Settled Dust Sampling

(Analysis by 3 Labs) *Diagnostic*

■ **#1 Results:** (DACI Lab) Normal levels of typical home allergens from building occupancy with people who have pets. No mice or cockroach indicators. Elevated mold levels in many 1st floor carpets.

■ **Info. Appendix. #B7**

C.A.R.: #10, Replace carpet, improve housekeeping.

3.11 Settled Dust Sampling

(Analysis by 3 Labs) *Diagnostic*

■ **#2 Results:** (EMLabs) Elevated microbial levels in many 1st floor carpets, some other locations. TBS requested more NIOSH carpet dust sampling and Lab analysis.

■ **Info. Appendix. #B4, B5**

C.A.R.: #10, Replace carpet, improve housekeeping.

3.11 Settled Dust Sampling

(Analysis by 3 Labs) *Diagnostic*

- **#3 Results:** (Aerotech Lab) Particle Morphology, no elevated levels of fiberglass. Typical dirt, skin scale, and some minor indications of soot in dust.
- **Info. Appendix. #B4, B5**
C.A.R.: #10, Replace carpet, improve housekeeping.

3.12 .1 Sewer Venting Evaluations

(Tracer Smoke Testing) *Diagnostic*

- **Results:** *Good News:* No hidden leaks in walls or above ceilings. *Not so good news:* eighteen dry traps located.
- **Info. Appendix. #C2**
C.A.R.: None Specified, Common issue in some buildings. Improved maintenance? trap primers? .

Theatrical Smoke @ Sewer Vents



Emerging from dry trap

Emerging from shower stall

Copyright Turner Building Science & Design, LLC 2007

49

Summary of CAR's:

- Replace HVAC
- Replace Boilers
- Evaluate Chiller
- Prof. Clean Ductwork
- Rebuild 1978 Exterior Walls
- Reseal 1991 Bermed Exterior
- Prof. Seal Gross Air Leakage
- Replace 1978 Windows, 10% open
- Eliminate Wetting and ThermBypass
- Clean & Refinish Interior
- Reduce Excess Outdoor Air Delivery
- Isolate & Exhaust High Use Photocopiers
- Isolate Tobacco Further From Building

Copyright Turner Building Science & Design, LLC 2007

Some General Healthy Building Principles:

■ Reduce Sources examples:

- Keep carpet clean and dry enough that it does not become a garden. Dry all spills completely within 24 hr.
- Run laminators cool enough to not overly melt plastic.
- Keep floor drain traps filled.

■ Provide Thermal Comfort

- Meet ASHRAE Guidelines for temperature and drafts
- Keep RH below 60 summer, above 20? Winter
- i.e. don't over-ventilate under design conditions

Copyright Turner Building Science & Design, LLC 2007

Some General Healthy Building Principles:

■ Exhaust Point Sources examples:

- Bathrooms and Toilet Areas.
- All High Use Photocopier and any laminator.
- Chemical Storage Areas & Cooking Areas

■ Provide ASHRAE STD 62 dilution ventilation for occupant bio-effluents.

■ Reduce Unplanned Air Flow

- Drain lines, Air leaks, dumpsters, boilers

Copyright Turner Building Science & Design, LLC 2007

Questions & Comments



Steven M. Caulfield, P.E., CIH
William A. Turner, M.S., P.E.
Turner Building Science & Design, LLC

1-800-439-3446

www:
turnerbuildingscience.com