Audits and Retro-Commissioning Complications of Healthcare Facilities

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Agenda

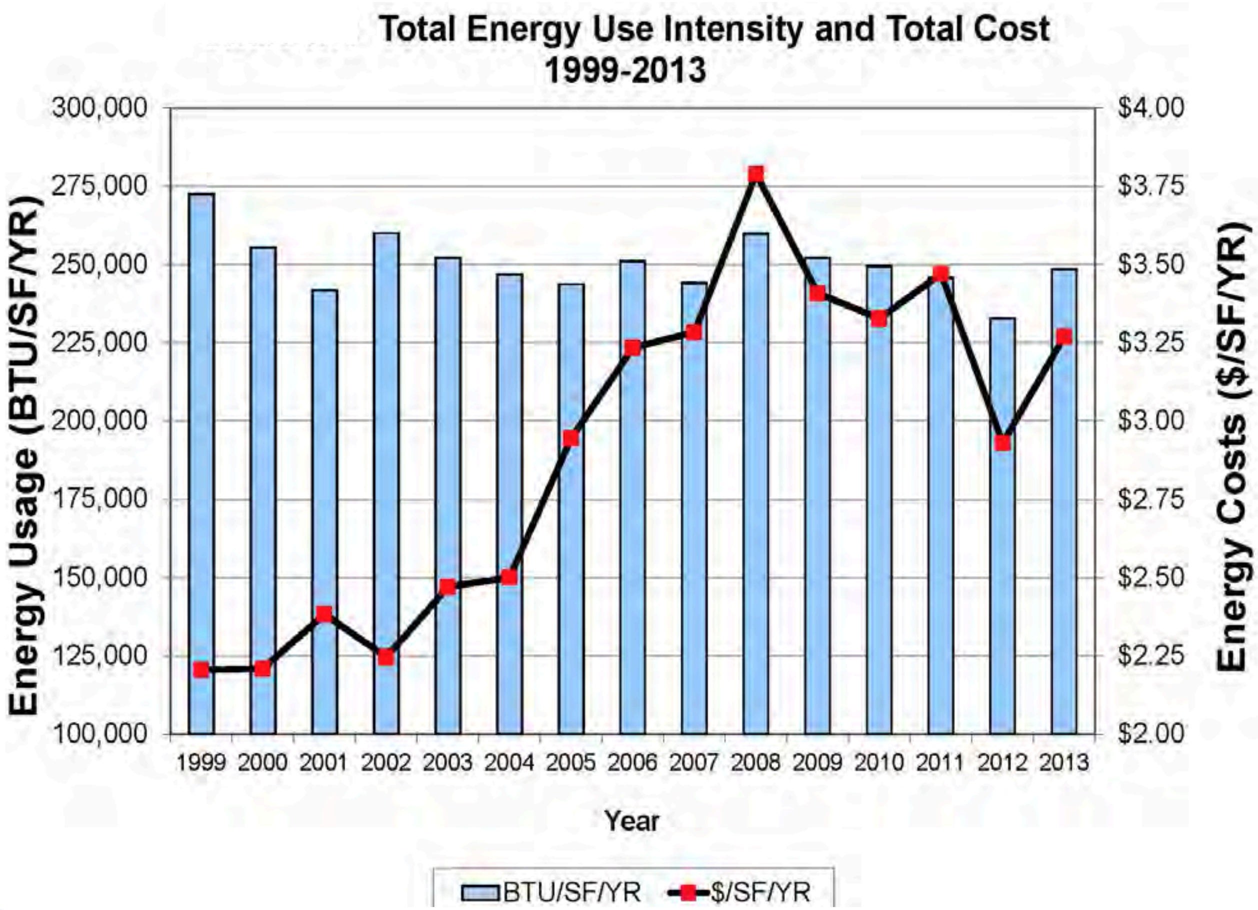
- Hospital Energy and Water Benchmarking Survey
- What makes a good RCx candidate?
- Real-world examples and case studies of retro-commissioning and audits in action, and the surprising findings . . .

Hospital Energy Survey

- G/BA has been doing an energy benchmarking survey for healthcare institutions in Illinois, Wisconsin, and scattered other states since 1995
- In 2013 (the last data compiled), HES included more than 73 million square feet
- Over 2.3 billion kWh, costing over $176 million
- Over 104 million therms of natural gas, costing approximately $76 million.
- Over 2,410,000 tons of equivalent carbon dioxide emissions

Energy Usage and Cost Trends

Energy usage as an industry has held steady, with increasing costs

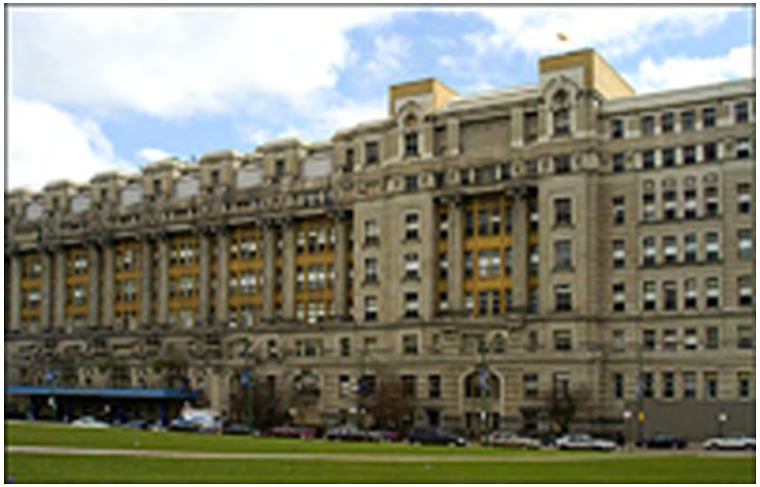


What do the numbers mean?

Is 10 MPG high or low for an automobile?

Answer: Common knowledge

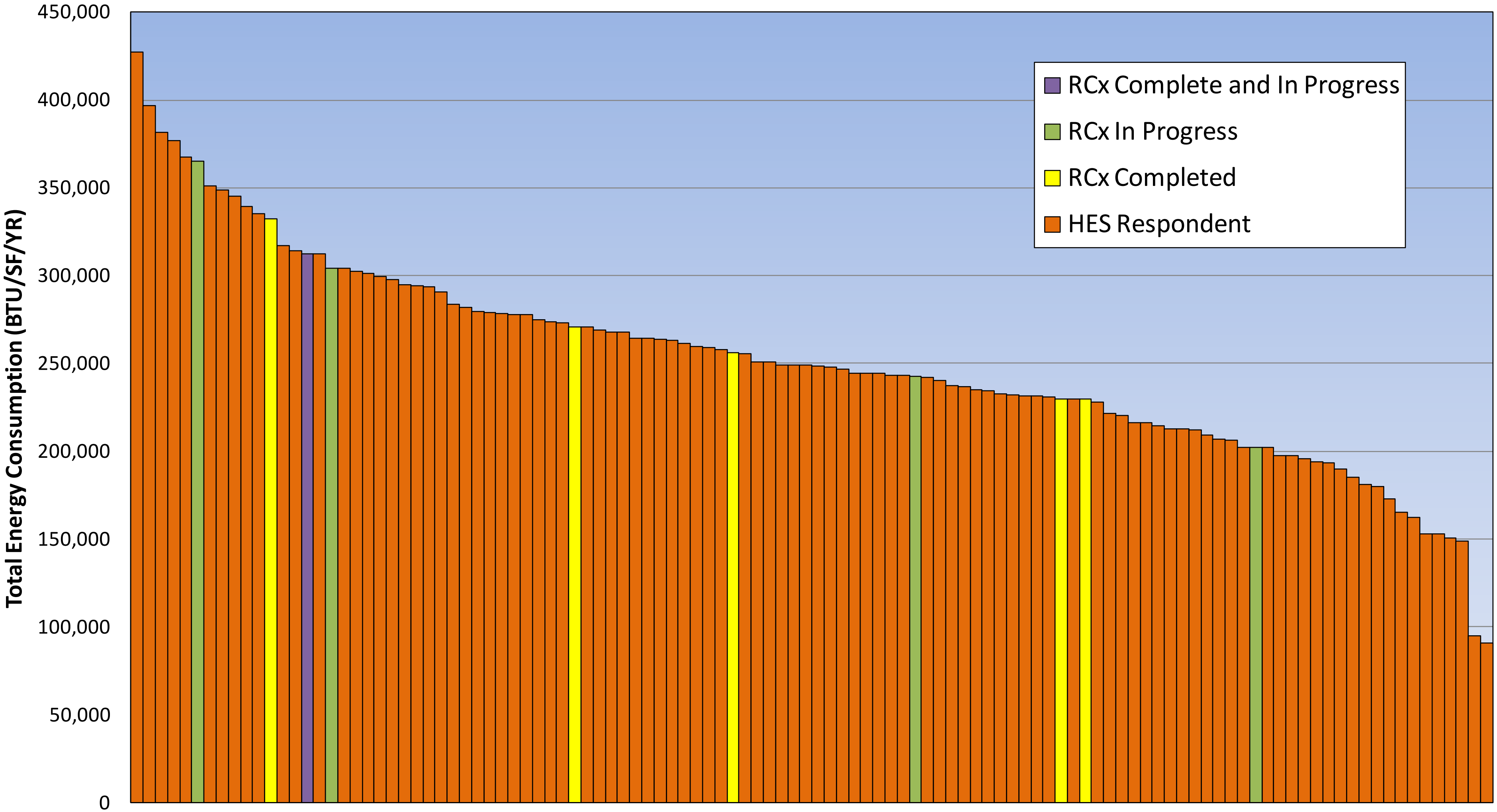
Is 350 kBtu/SF/YR high or low for a hospital?



Answer: ???

Year 2010 G/BA Hospital Energy and Water Benchmarking Survey

For 2009 Total Energy Consumption (BTU/SF/YR)



10 out of 14 RCx hospitals are in the survey

Identify All Energy-Using Systems

- Lighting – Prescriptive incentive programs
- Plug loads – Difficult
- Heating – **RCx**
- Cooling – **RCx**
- Fans/Pumps – **RCx**
- Process – Possible
  - DHW
  - Kitchen
  - CHW (imaging)

Our RCx Definition

- RCx is a process of finding, investigating and solving variable and unknown problems with a defined process and custom solution
- Some say – try to bring the building and systems back to origin design intent or performance. Really?
- Test and repair what is broken – OK, but there is still more . . .
- Optimize and enhance the existing building and systems to the current operation and use of the building with the latest technology enhancements

Retro-Commissioning

- G/BA results from nearly 23 million square feet, composed of 24 healthcare sites made up of over 100 buildings
- 5% average electrical savings (kWh)
  - Highest savings 36.2%
  - Lowest savings 0.8% (Not all identified measures were implemented, and facility had been retro-commissioned five years before.)
- Harvest Rate = Planned vs. Verified kWh savings
- Typical Harvest Rate < 90%
- LBNL Study 224 Buildings = 15% Energy Savings (*Caution*)

Retro-Commissioning

- Most common RCx controls measures
  - Scheduling equipment or VAV boxes
    - Turn equipment off
    - Program occupied/unoccupied setpoints for temperature, pressure, cfm
  - Sequence of operations optimization through "*<u>proactive</u>*" setpoint controls
    - Discharge air reset based on amount of reheat
    - Static pressure reset based on VAV damper position
    - Chilled water pump DP setpoint reset based on CHW valve position
  - Outside air control and economizer optimization
  - Reduced simultaneous heating and cooling
  - Chilled water system optimization

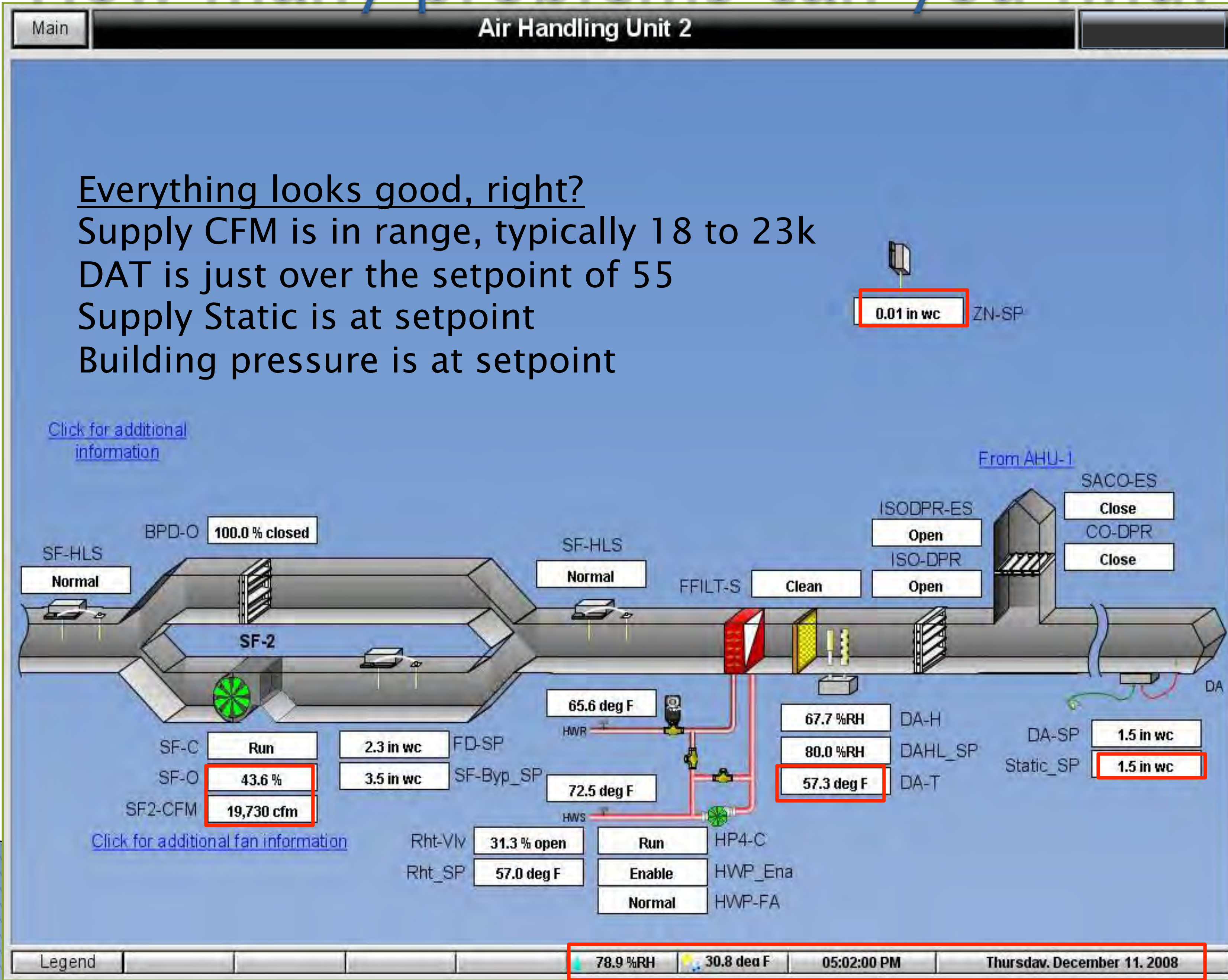
Retro-Commissioning

- Most common RCx equipment fixes
  - Replace broken/failed controls sensors
  - Repair/replace failed or seized dampers
  - Repair/replace failed or leaky valves
  - Correct pneumatic damper/valve operations
  - Air/water balancing

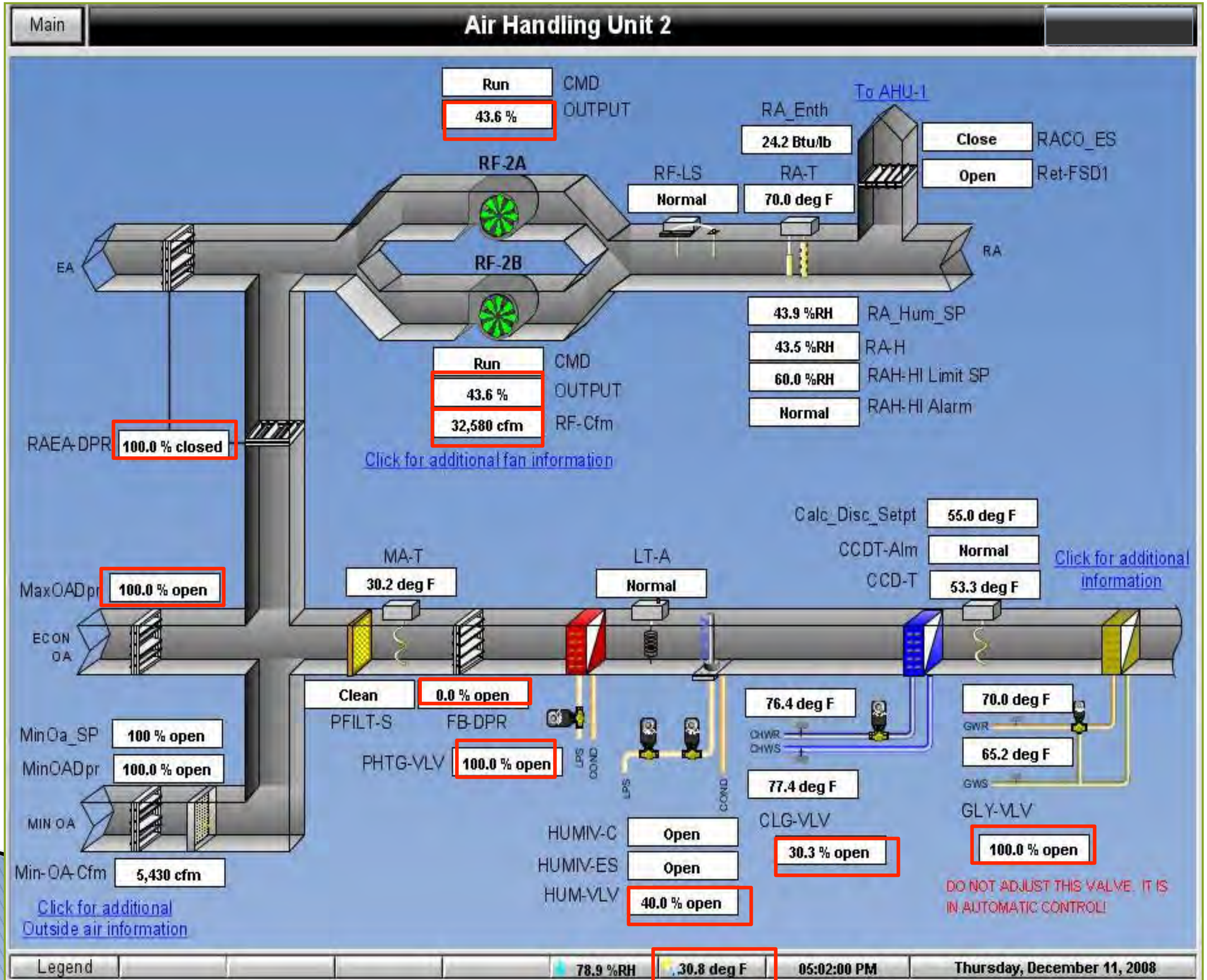
Complications in Healthcare HVAC Systems

Air Systems

How many problems can you find?



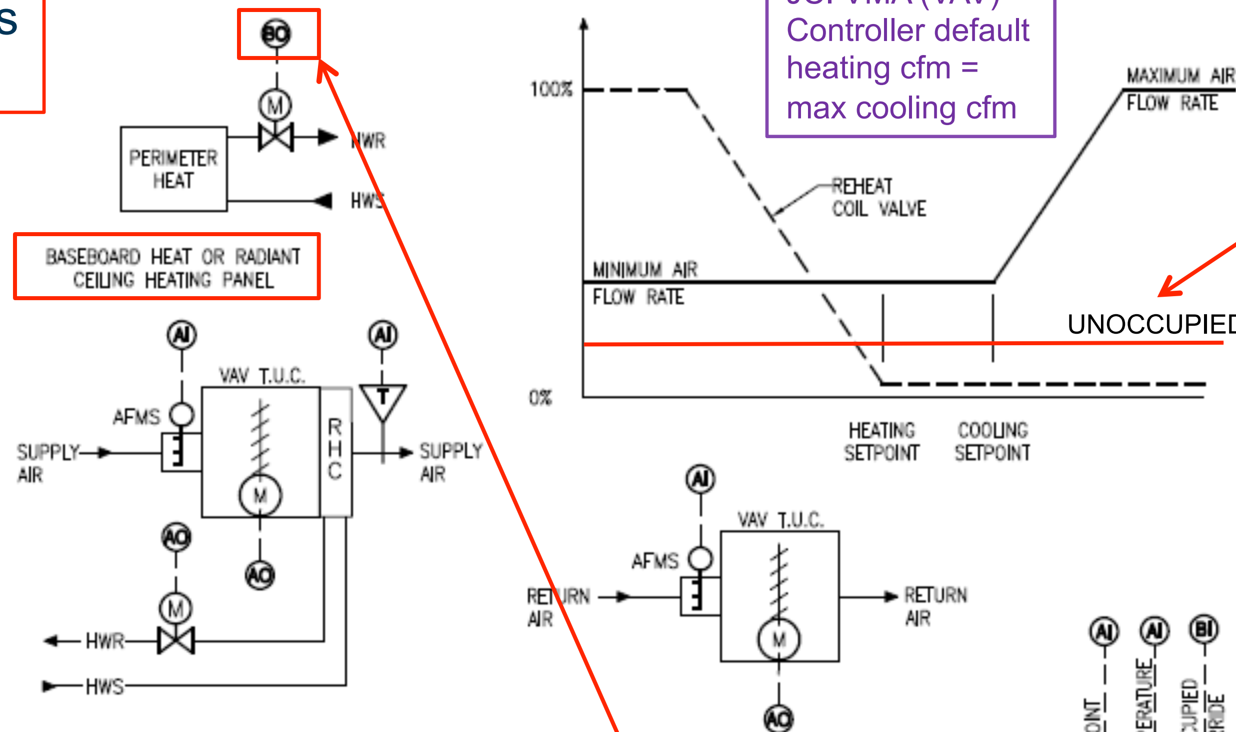
How many problems can you find?



Case Study #1 – VAV Patient Rooms Overheating

VAV Controls Diagram

CONTROL DIAGRAM



JCI VMA (VAV) Controller default heating cfm = max cooling cfm

Review unoccupied air flow rates, many systems are not programmed to have unoccupied setpoints!

Review Global points that command systems, this system had radiant heat coming on at 50 deg, which overheated the building causing simultaneous heating and cooling.

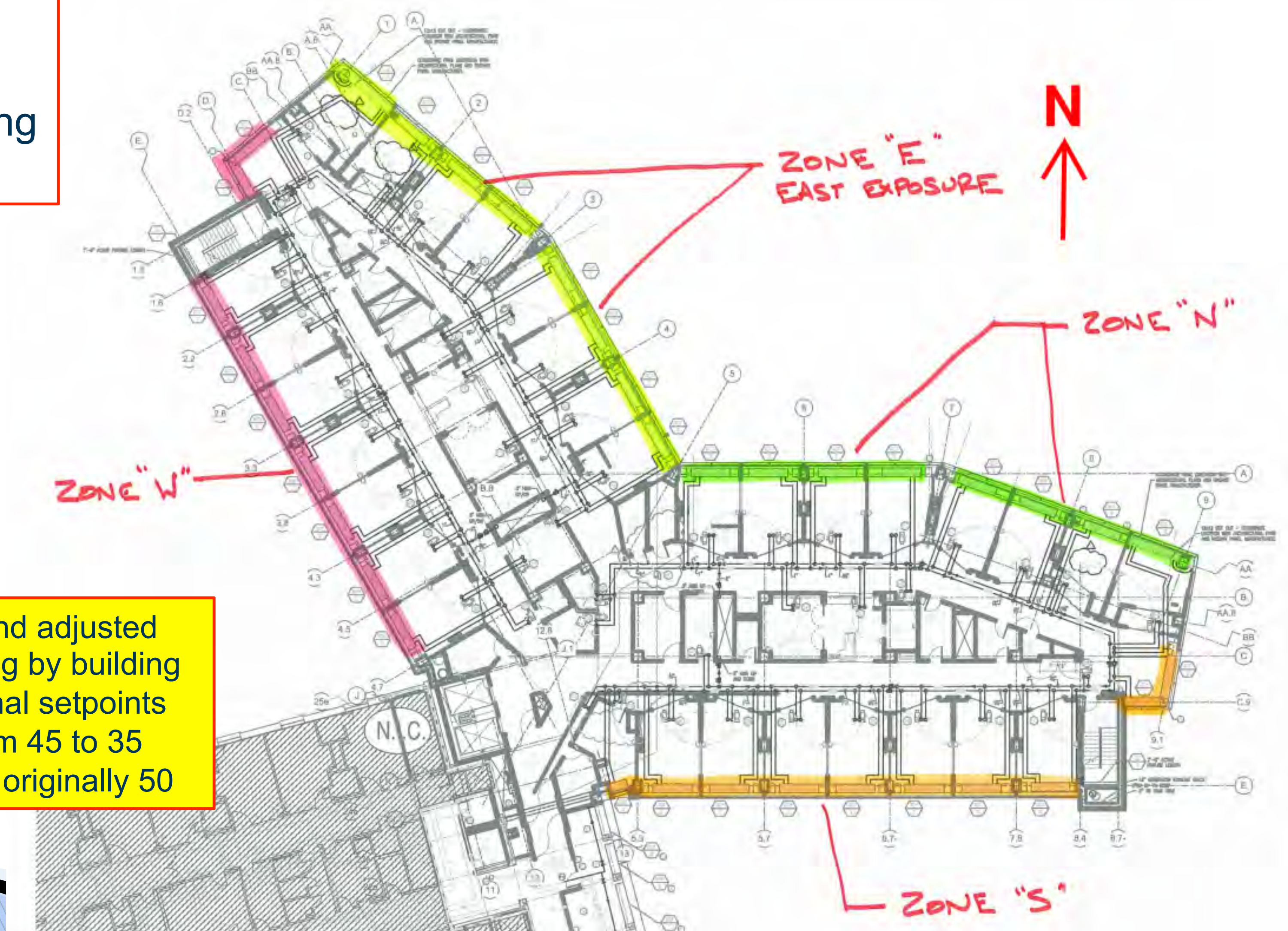
POINTS LIST

POINT TYPE	DESCRIPTION	COMMENTS
BI BI	SPACE OCCUPIED / UNOCCUPIED MODE RADIANT HEAT ACTIVE	GLOBAL VIRTUAL POINT
BO	PERIMETER HEAT VALVE	
AI AI AI AI AI	SPACE TEMPERATURE SPACE TEMPERATURE SETPOINT SUPPLY AIR TEMPERTURE SUPPLY AIR FLOW RETURN AIR FLOW	
AO AO AO	SUPPLY AIR DAMPER REHEAT COIL VALVE RETURN AIR DAMPER	

Tested and adjusted by building exposure, final setpoints ranged from 45 to 35 degrees OA

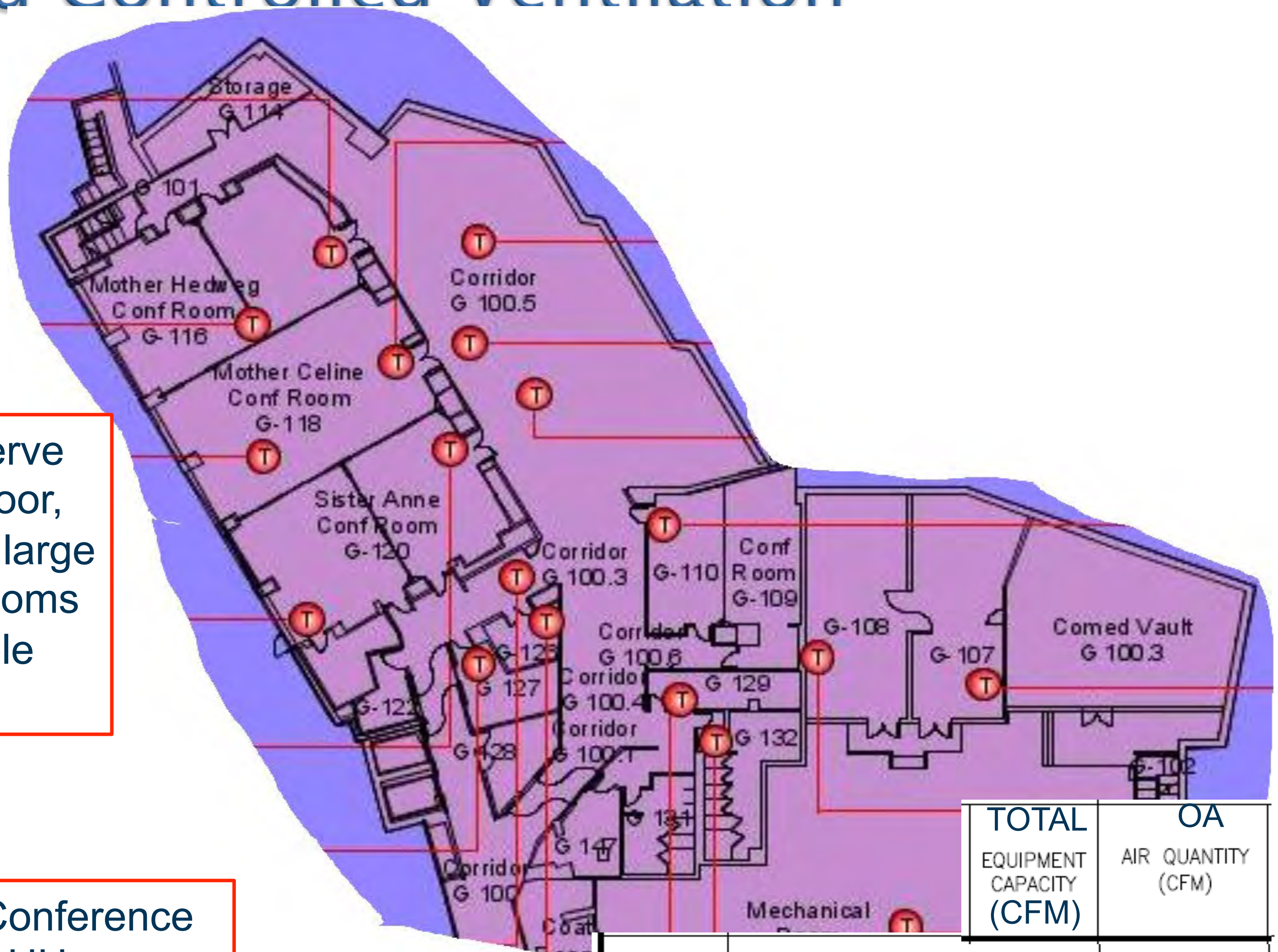
Case Study #1 – VAV Patient Rooms Overheating

Revised Radiant Panel Zoning Diagram



Cx tested and adjusted radiant heating by building exposure, final setpoints ranged from 45 to 35 degrees OA, originally 50

Case Study #2
Demand Controlled Ventilation

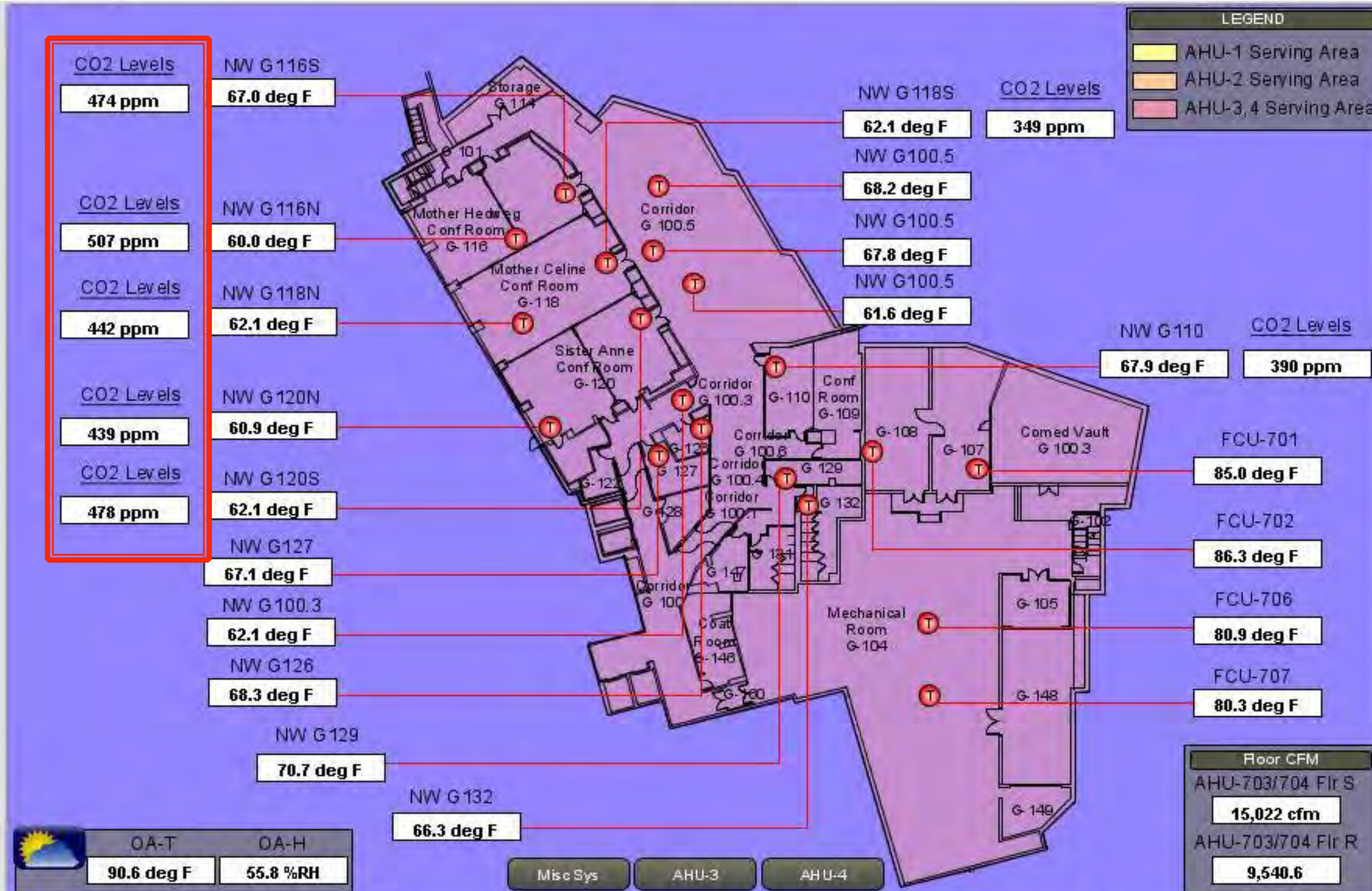


The AHUs serve the ground floor, which has five large conference rooms with movable partitions

60% OA for Conference Room AHUs

		TOTAL EQUIPMENT CAPACITY (CFM)	OA AIR QUANTITY (CFM)
S–3	SUPPLY	12,500	7,500
S–4	SUPPLY	12,500	7,500

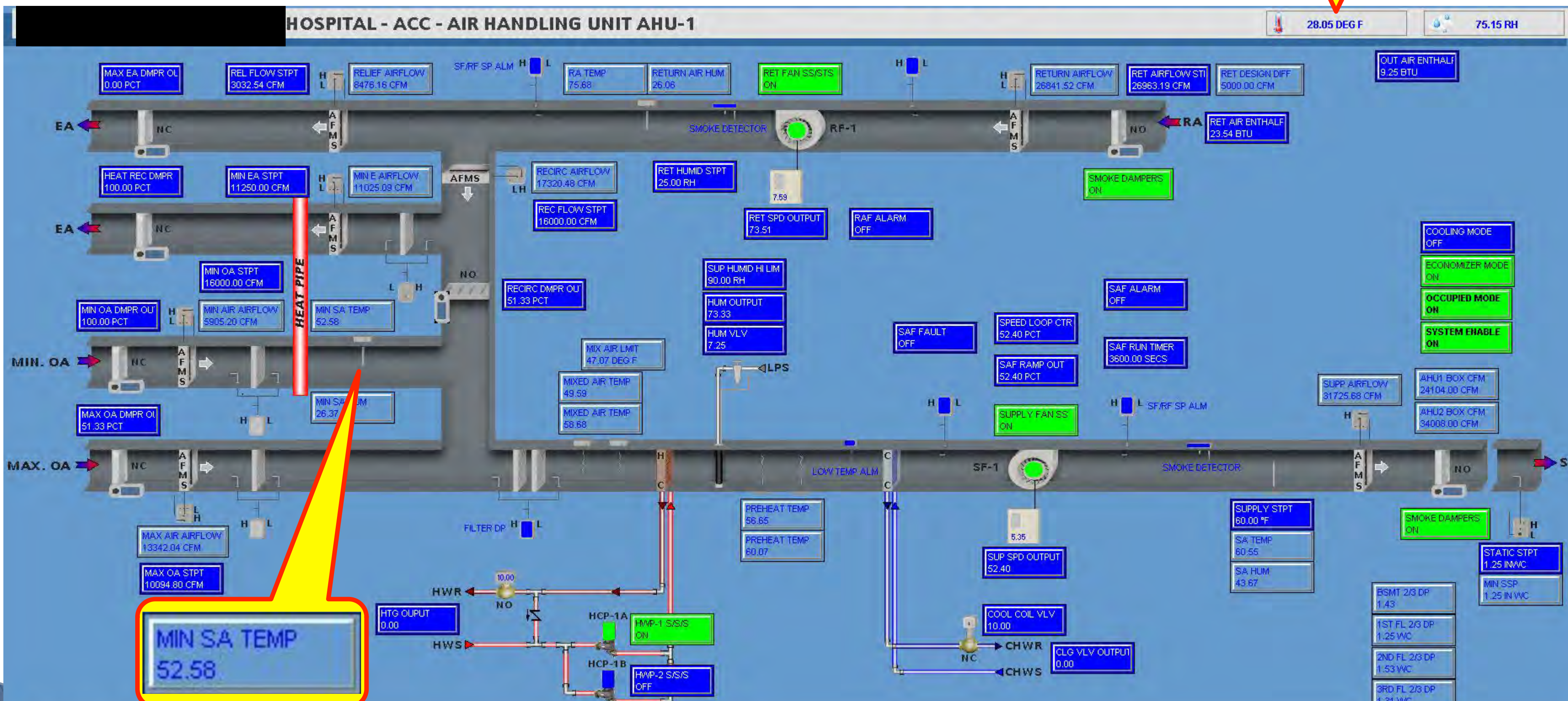
Case Study #2
Demand Controlled Ventilation



Case Study #3 – Heat Pipe

VAV system with Heat Pipe on OA intake provide a 24 degree rise in OA temp with no energy costs!

28.05 DEG F



Cx found a bad Max OA flow station and a sequence that did not work, which was causing the NON-heat pipe exhaust to open, eliminating the effectiveness of the heat pipe.

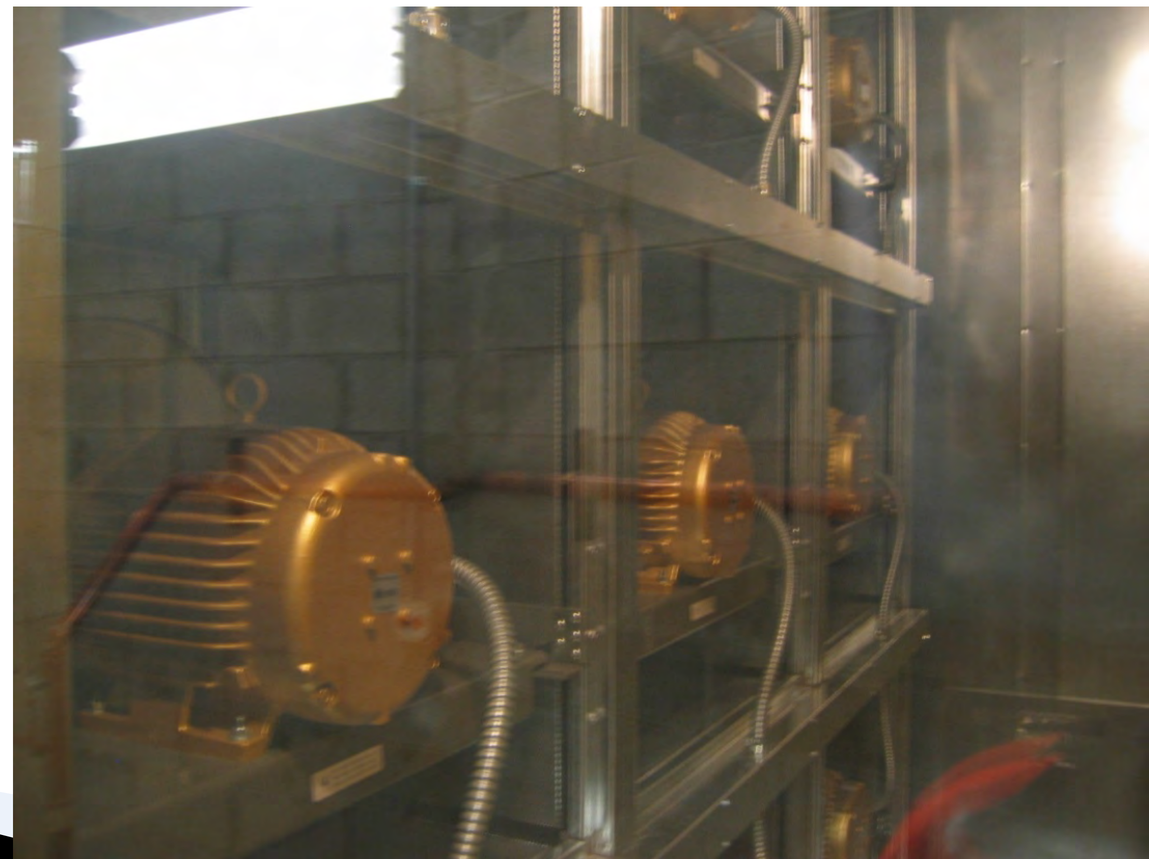
Complications in Healthcare HVAC Systems

Fan Walls

Complications in Healthcare HVAC Systems

New Advancement: Fan Wall Technology

Equals = New Cx challenges



Complications in Healthcare HVAC Systems

- Fan Wall Technology:
  - VFDs running above or below 60Hz
  - Redundant drives
  - Redundant drive wiring issue
  - Return fan still has bypass
  - Stratification Issues

If you thought you had stratification problems before, watch out:
they will likely get worse!

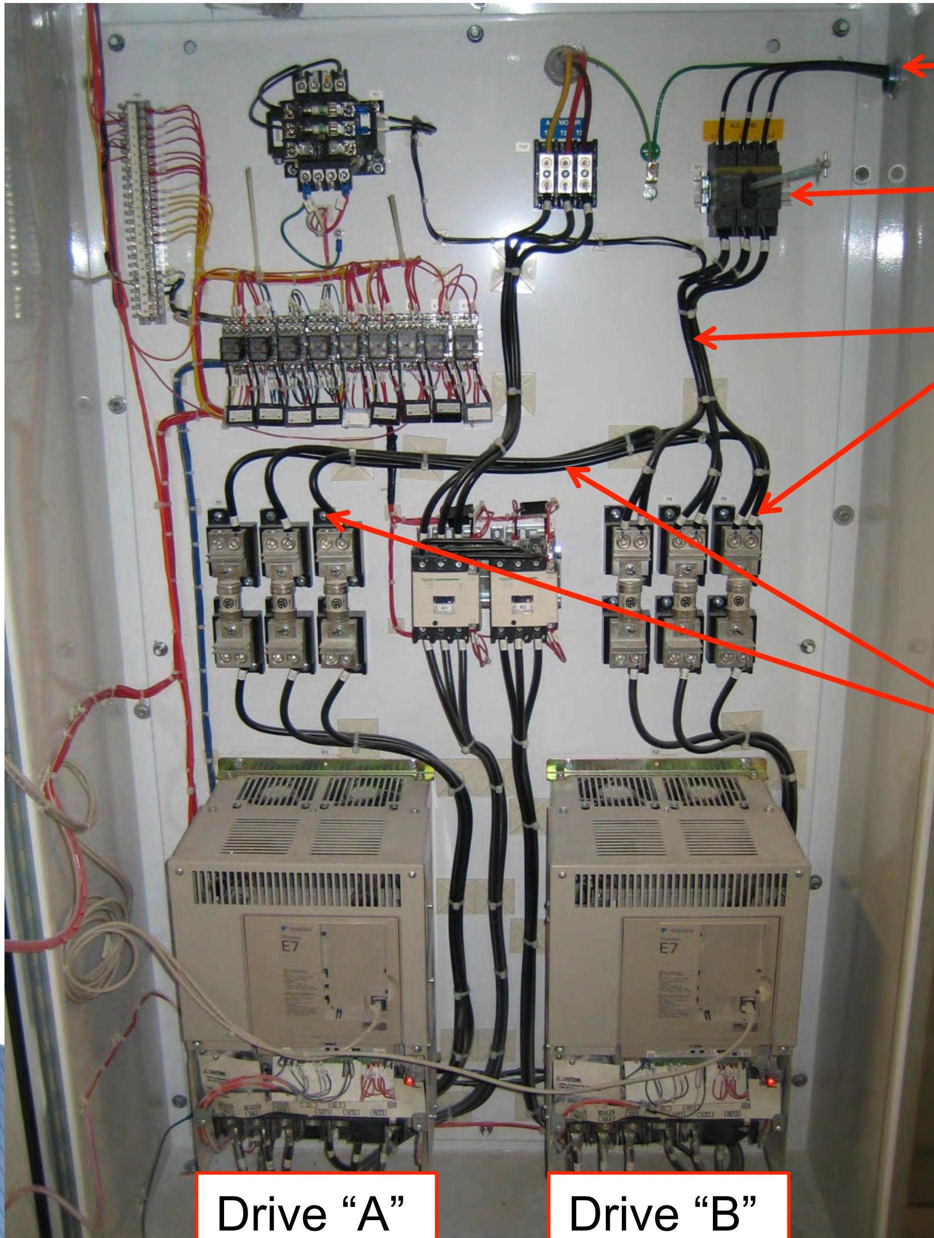
Complications in Healthcare HVAC Systems

Fan Wall Technology:

Standard VFD with Bypass

Dual VFD without Bypass

Dual VFD With Bypass: A Closer Look



Incoming Power

Main Disconnect Switch

Main Power to Drive “B” incoming fuse terminal lugs

Drive “A” is powered from Drive “B”

Drives cannot be internally isolated from each other without rewiring. Suggest two more internal disconnect switches.

Complications in Healthcare HVAC Systems

Air Flow Measuring Stations (AFMS)

AFMS Example #1

LOCATION IS EVERYTHING

WHAT HAPPENS WHEN YOU CAN'T GET OA TO MEET THE DAT SP IN ECONOMIZER?

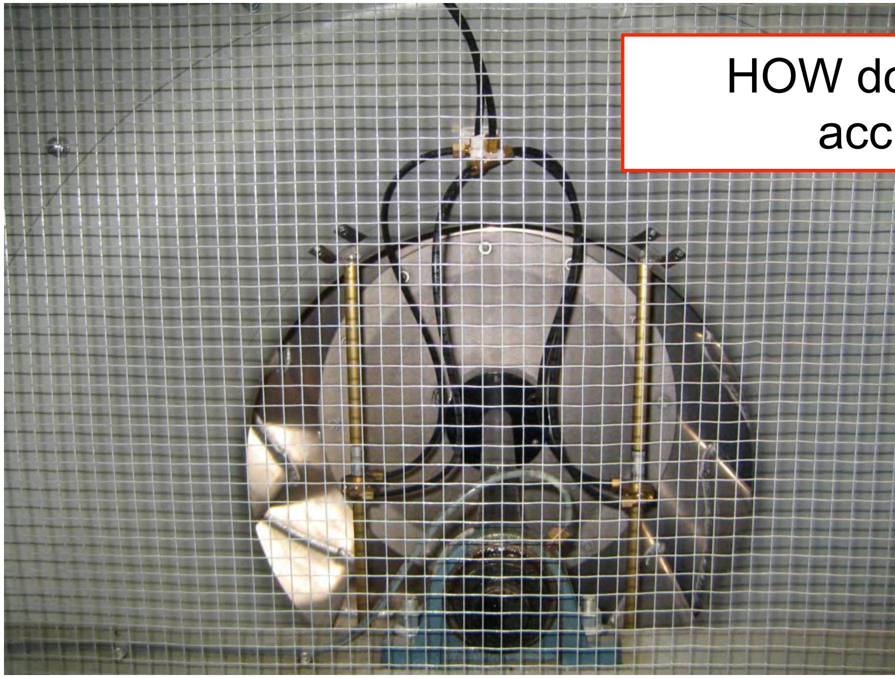
AFM tube behind duct plenum structural support

Minimum OA

Maximum OA

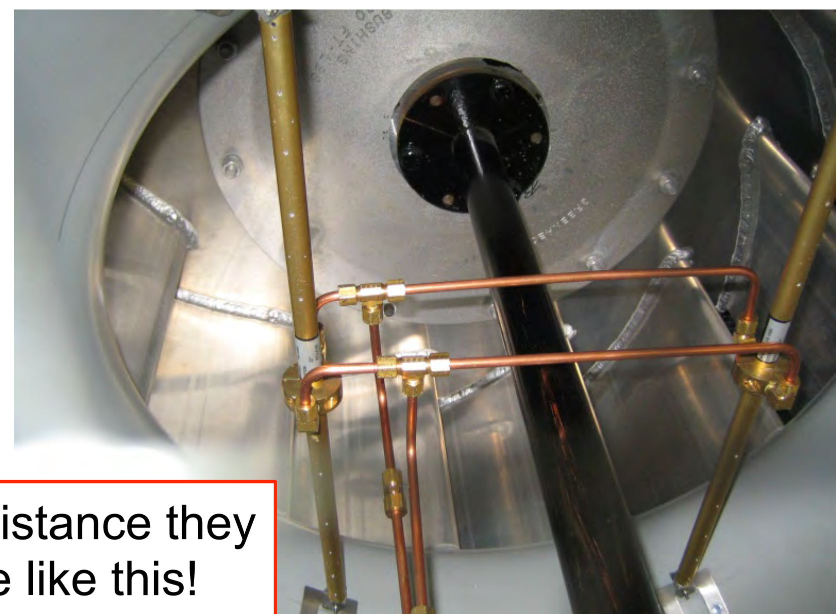
(2) Max OA air flow tubes

AFMS Example #2 – Before and After



HOW do you verify accuracy?

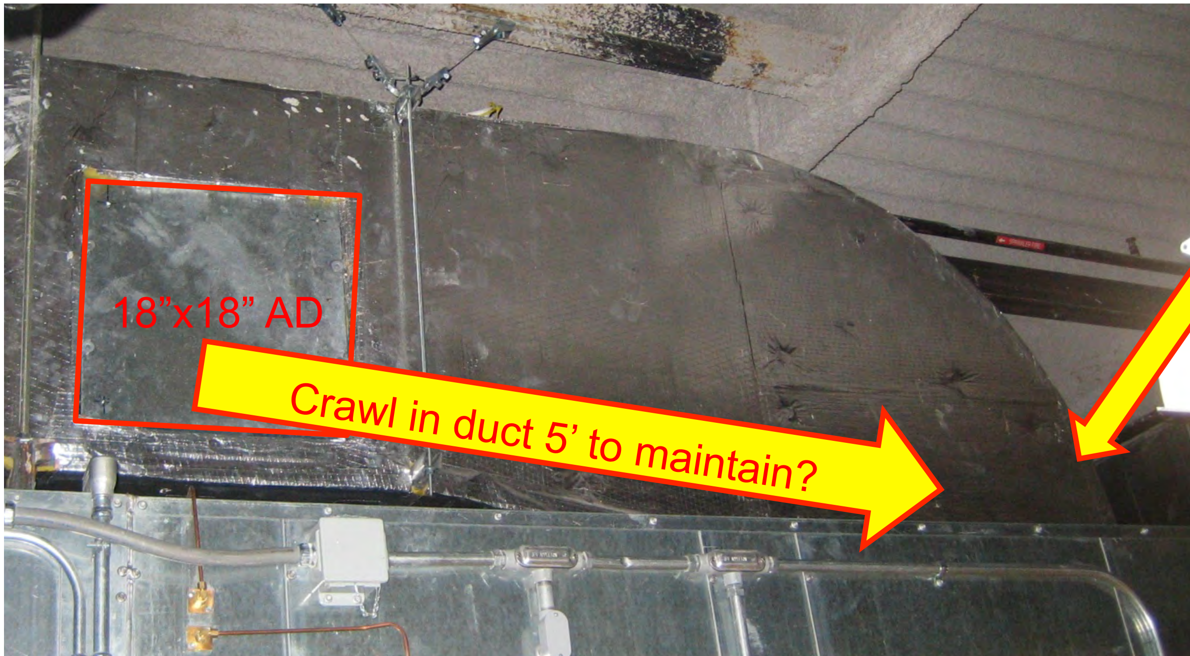
Poly tubing was not per the manufacturer's installation instructions and will fail due to vibration
PLUS was run and mounted on the inlet bell, which impacts fan efficiency



After much resistance they were redone like this!

AFMS Example #3

18” x 18” access door is ≈4’–5’ away from AFMS. Is this accessible?

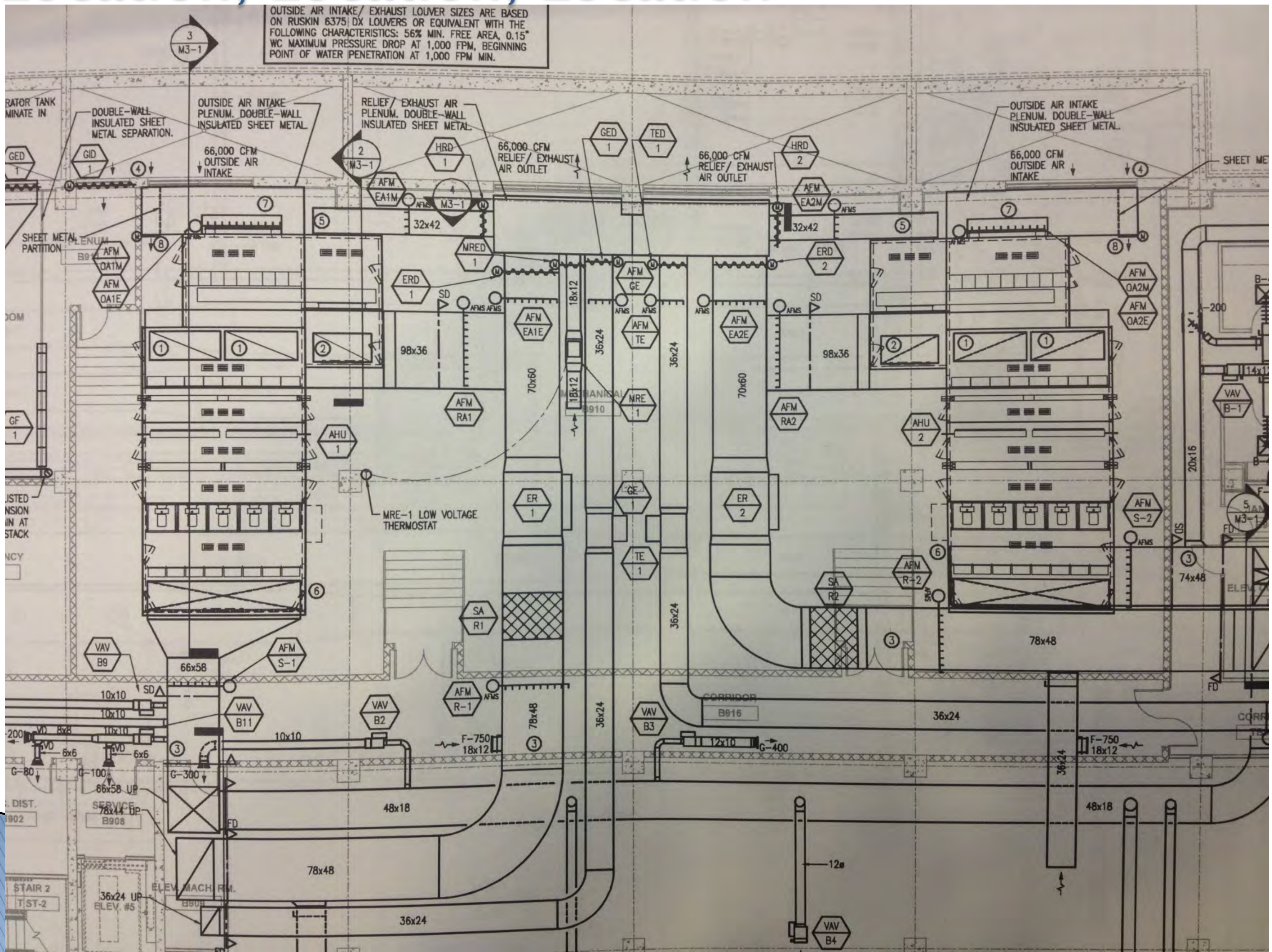


AFMS Example #3 – Location, Location, Location

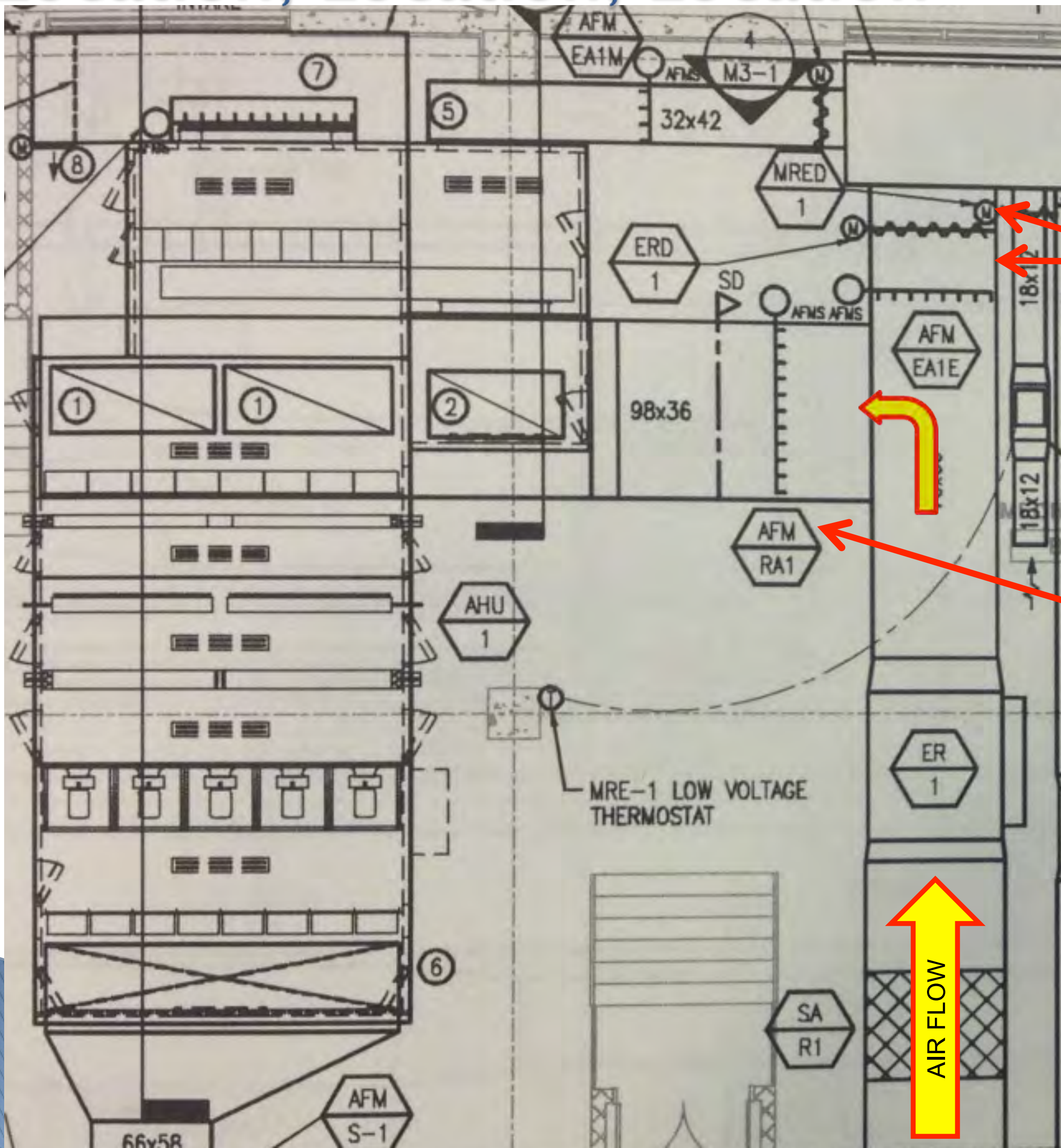
DUCT ELBOW

≈ 12" EBTRON FLOW MEASUREMENT TUBES (TYPICAL FOR 4)

AFMS Example #4 – Location, Location, Location



AFMS Example #4 – Location, Location, Location



Exhaust AFMS located directly inline with the discharge of the return fan AND directly in front of the exhaust relief damper. (Recommend locating AFTER the damper.)

Return AFMS is located after a 90º turn in airflow, yielding uneven airflow across the AFMS. Some technology can deal with this better than others.

Complications in Healthcare HVAC Systems

Building Pressurization

Case Study #4 – Building Pressurization

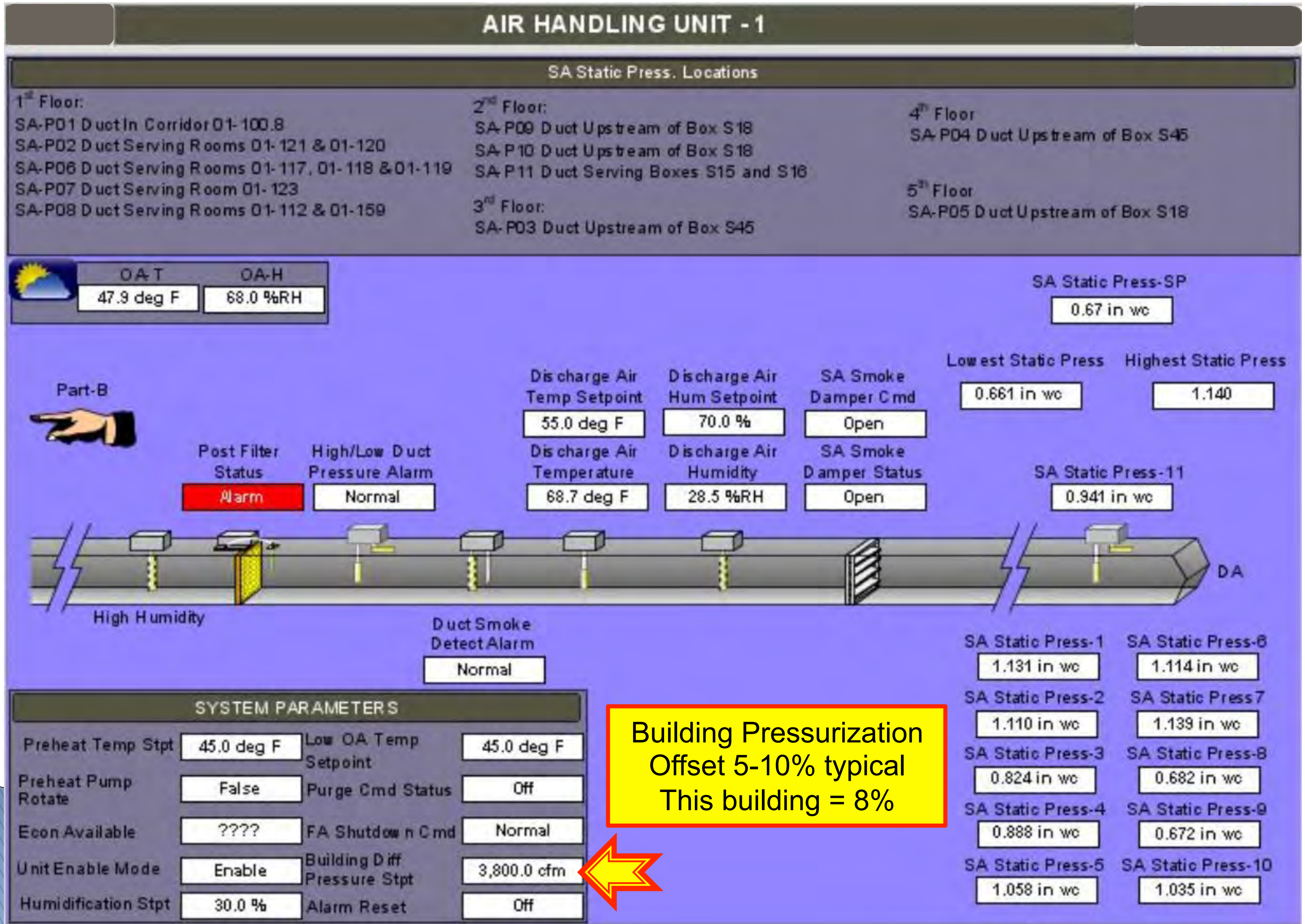
Tested and found much better than code 0.14 CFM/Sq.Ft.

Complications in Healthcare HVAC Systems (Case Study #4)

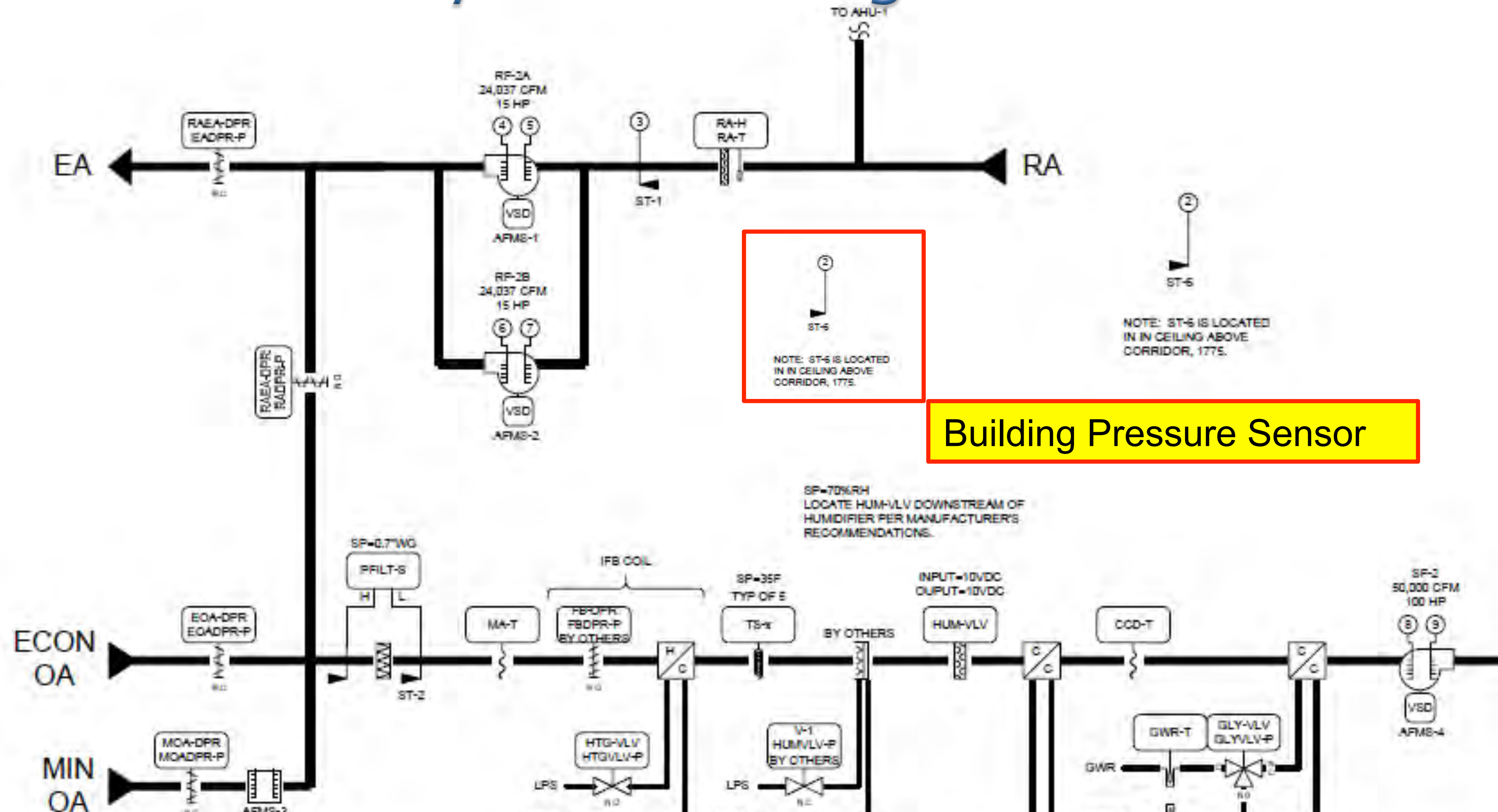
- AFMS – Fan tracking for building pressurization
- What is the fixed exhaust from area served?
- Minimum OA needs to be greater than fixed exhaust.
- Return fan cfm = Supply fan cfm – fixed exhaust – building pressurization offset (% of supply fan cfm) (typically 5-10%)

Building Pressurization Offset is determined in the field! Cx task to determine during FPTs.

Case Study #4 – Building Pressurization



Case Study #4 –Building Pressurization



AHU-2 BLANCING MATRIX

UNIT OPERATION	SUPPLY FAN CFM	EXHAUST FAN CFM	O.A. DAMPER CFM	RETURN FAN CFM	RELIEF DAMPER CFM	RETURN DAMPER CFM	REMARKS
MAXIMUM UNIT CAPACITY	50000	1925	12500	48075	10575	37500	SIZED FOR REDUNDANCY OF AHU-2
VAV BOXES AT MAX COOLING	30300	910	7575	29390	6665	22725	
VAV BOXES AT MAX HEATING	18310	910	4578	17400	3668	13733	
VAV BOX MINIMUMS	14860	910	3715	13950	2805	11145	

Case Study #4 –Pressurization

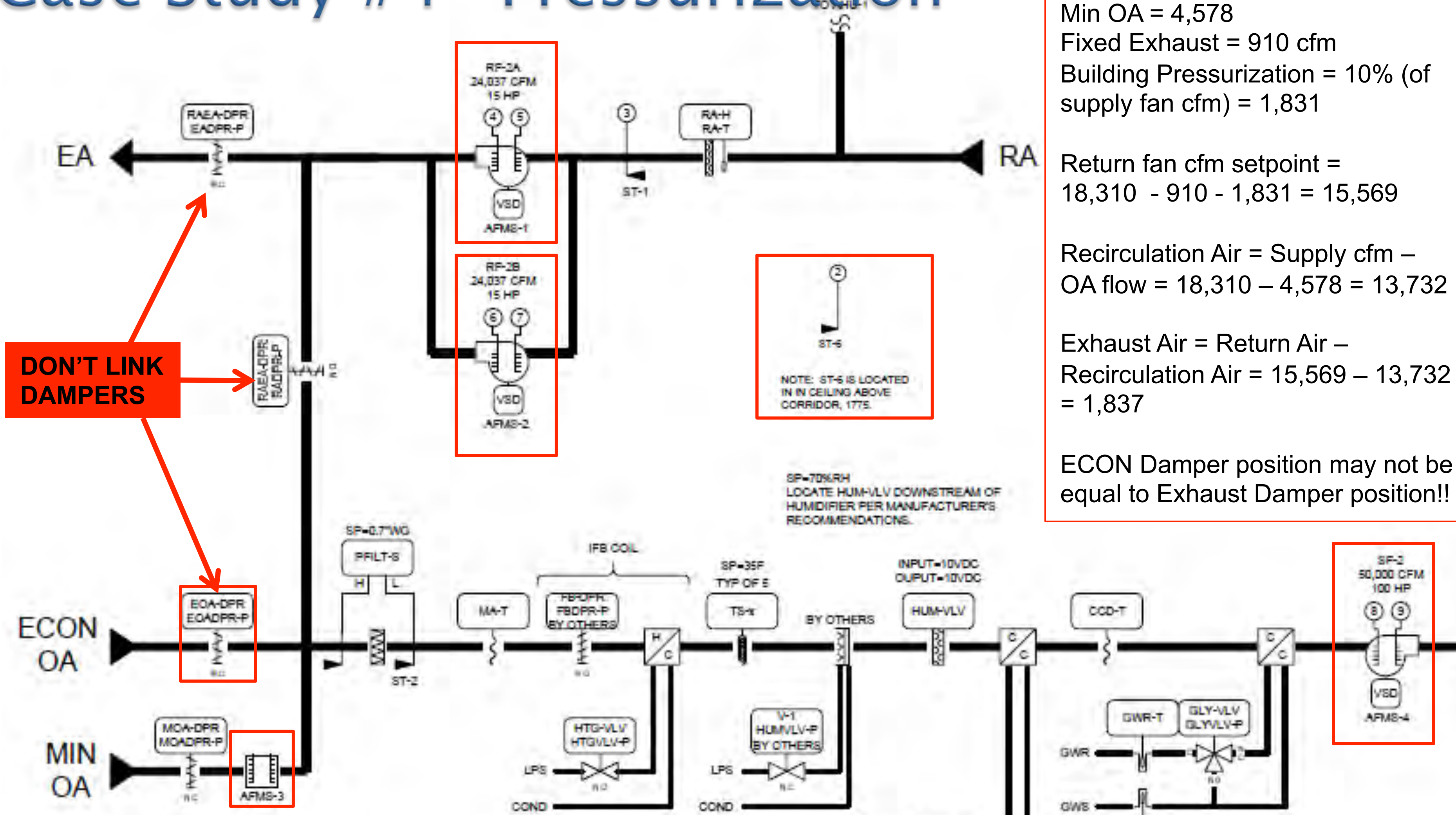
Supply cfm = 18,310
Min OA = 4,578
Fixed Exhaust = 910 cfm
Building Pressurization = 10% (of supply fan cfm) = 1,831

Return fan cfm setpoint = 18,310 - 910 - 1,831 = 15,569

Recirculation Air = Supply cfm – OA flow = 18,310 – 4,578 = 13,732

Exhaust Air = Return Air – Recirculation Air = 15,569 – 13,732 = 1,837

ECON Damper position may not be equal to Exhaust Damper position!!



PROBLEM – NOT ALL OA IS MEASURED

AHU-2 BLANCING MATRIX

UNIT OPERATION	SUPPLY FAN CFM	EXHAUST FAN CFM	O.A. DAMPER CFM	RETURN FAN CFM	RELIEF DAMPER CFM	RETURN DAMPER CFM
MAXIMUM UNIT CAPACITY	50000	1925	12500	48075	10575	37500
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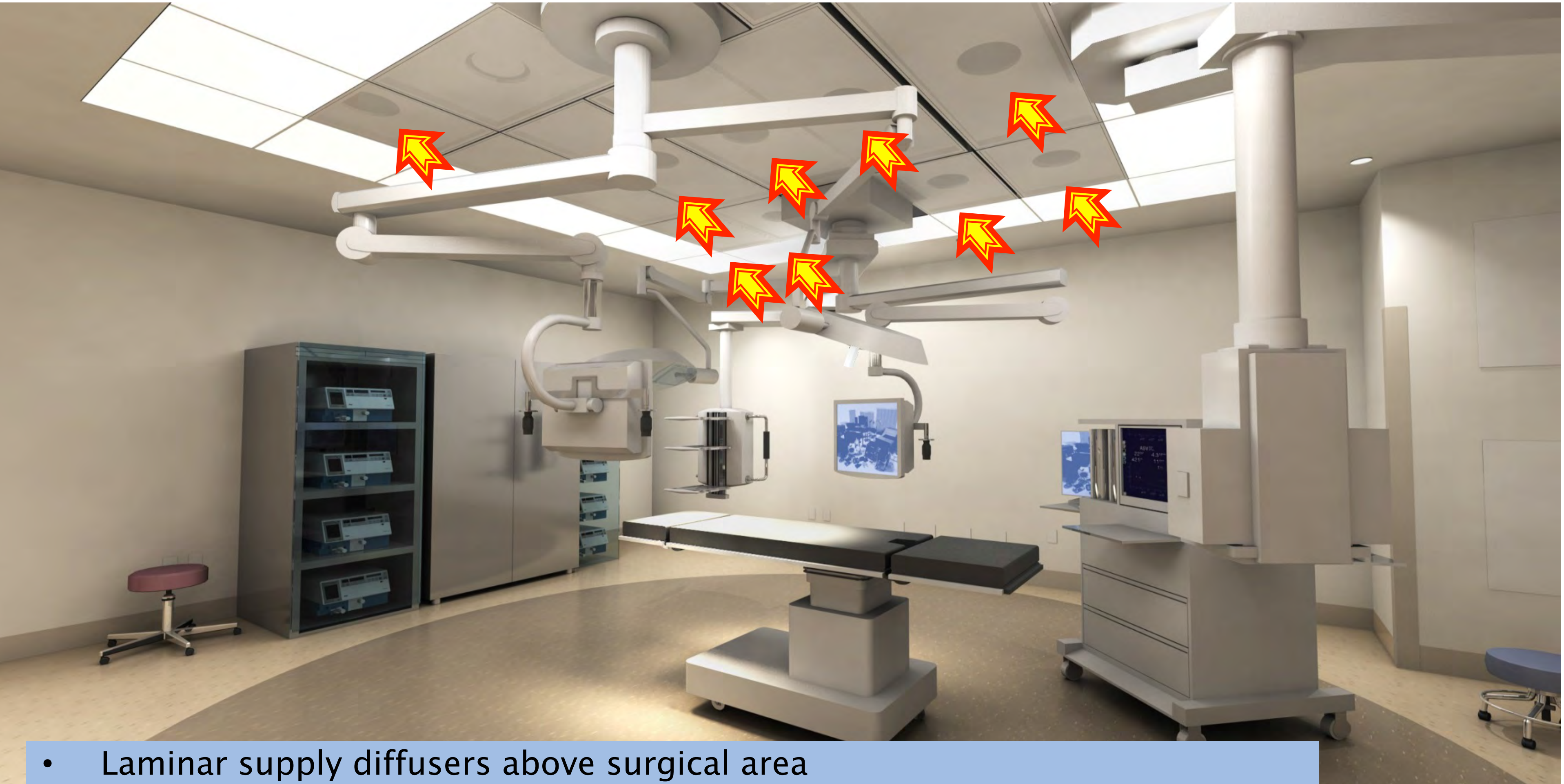
VAV BOX MINIMUMS	14860	910	3715	13950	2805	11145

PROBLEM – BALANCING MATRIX DID NOT LEAVE ANY AIR FOR BUILDING PRESSURIZATION

Complications in Healthcare HVAC Systems

Operating Rooms

General Design – Supply Air

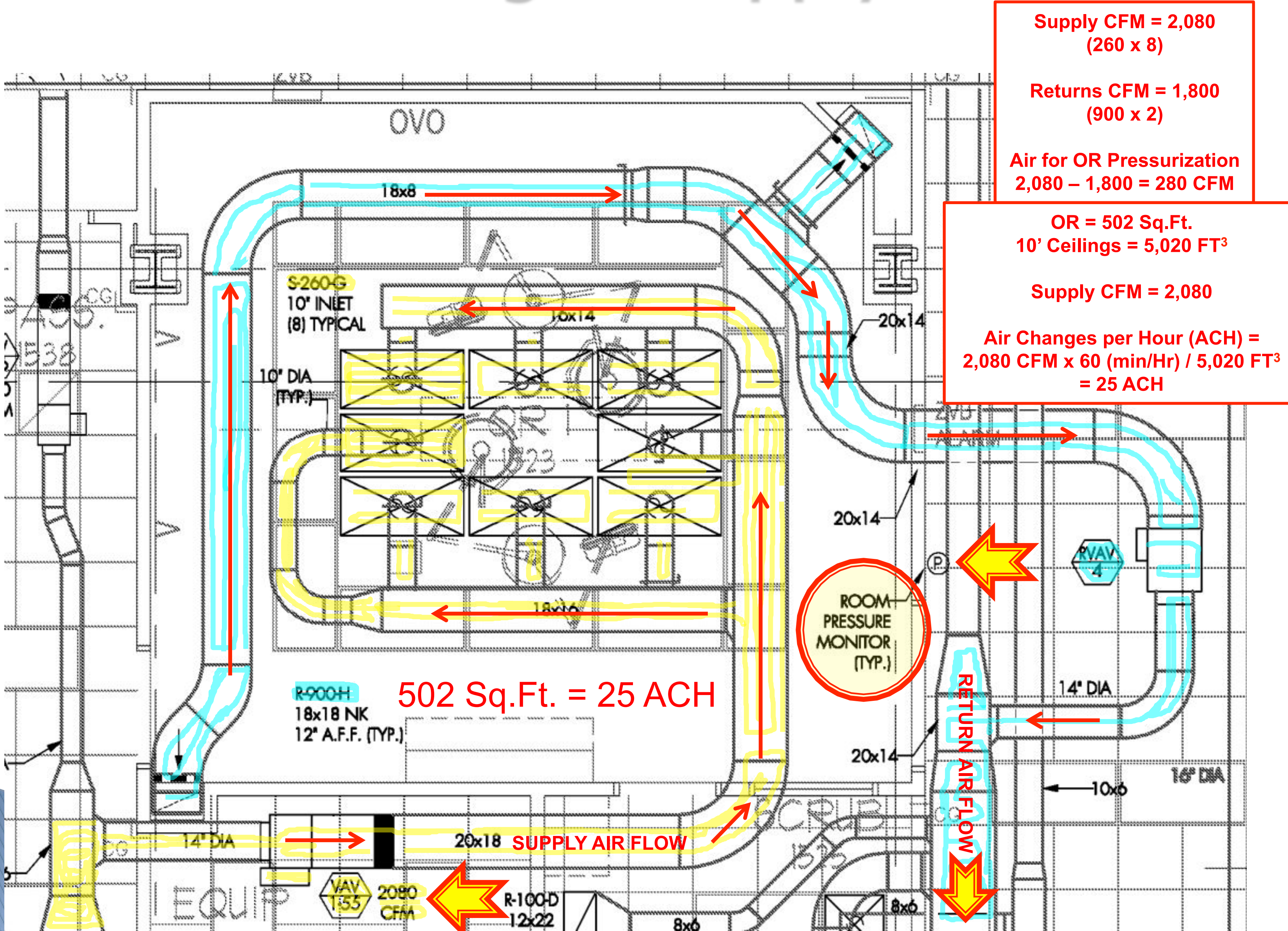


- Laminar supply diffusers above surgical area
- HEPA filtration
- Supply air washes down over patient and away to corners of OR

General Design – Return Air

Typically, 2 or 3 low returns in the corners of OR on opposite sides

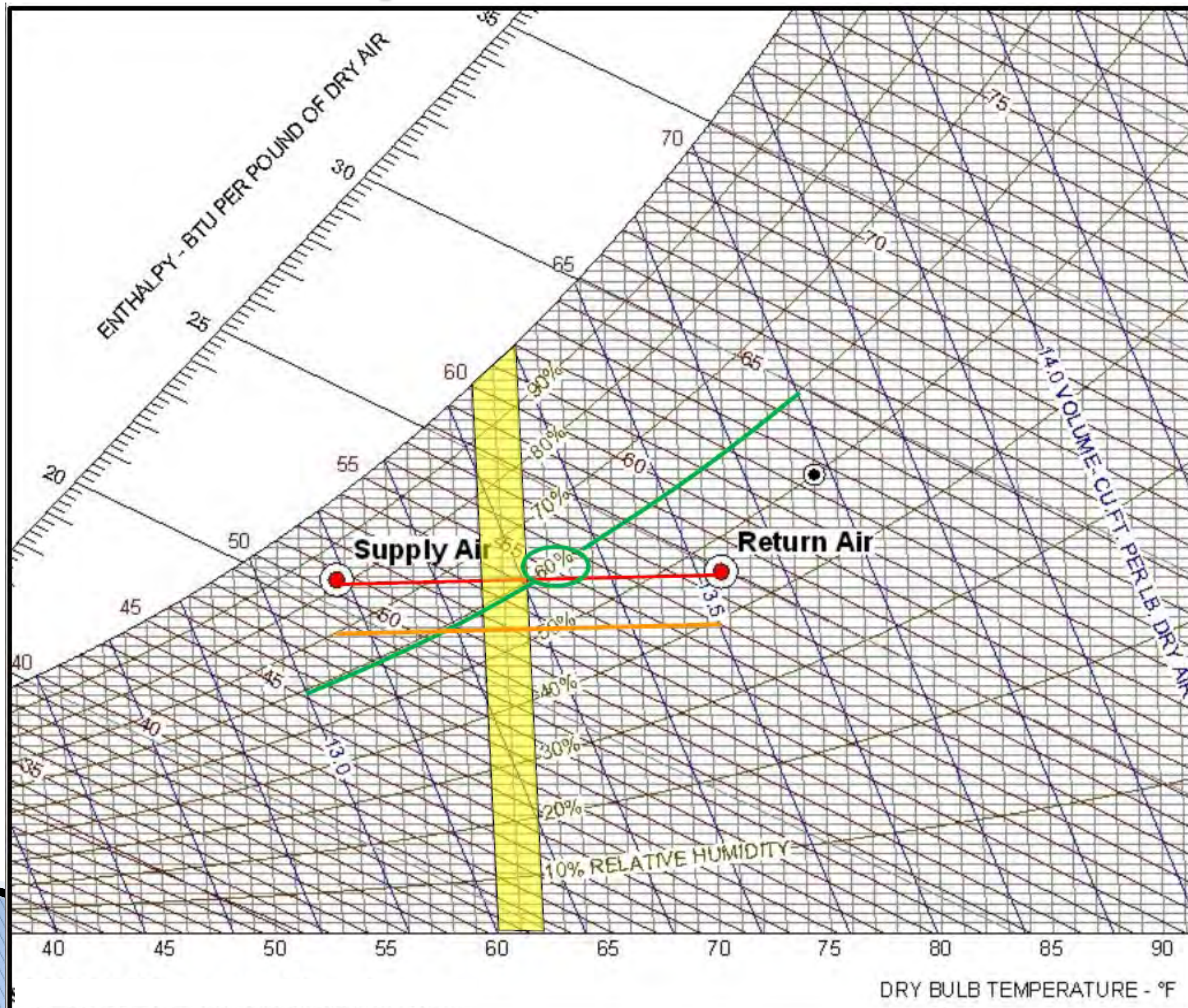
OR General Design – Supply and Return



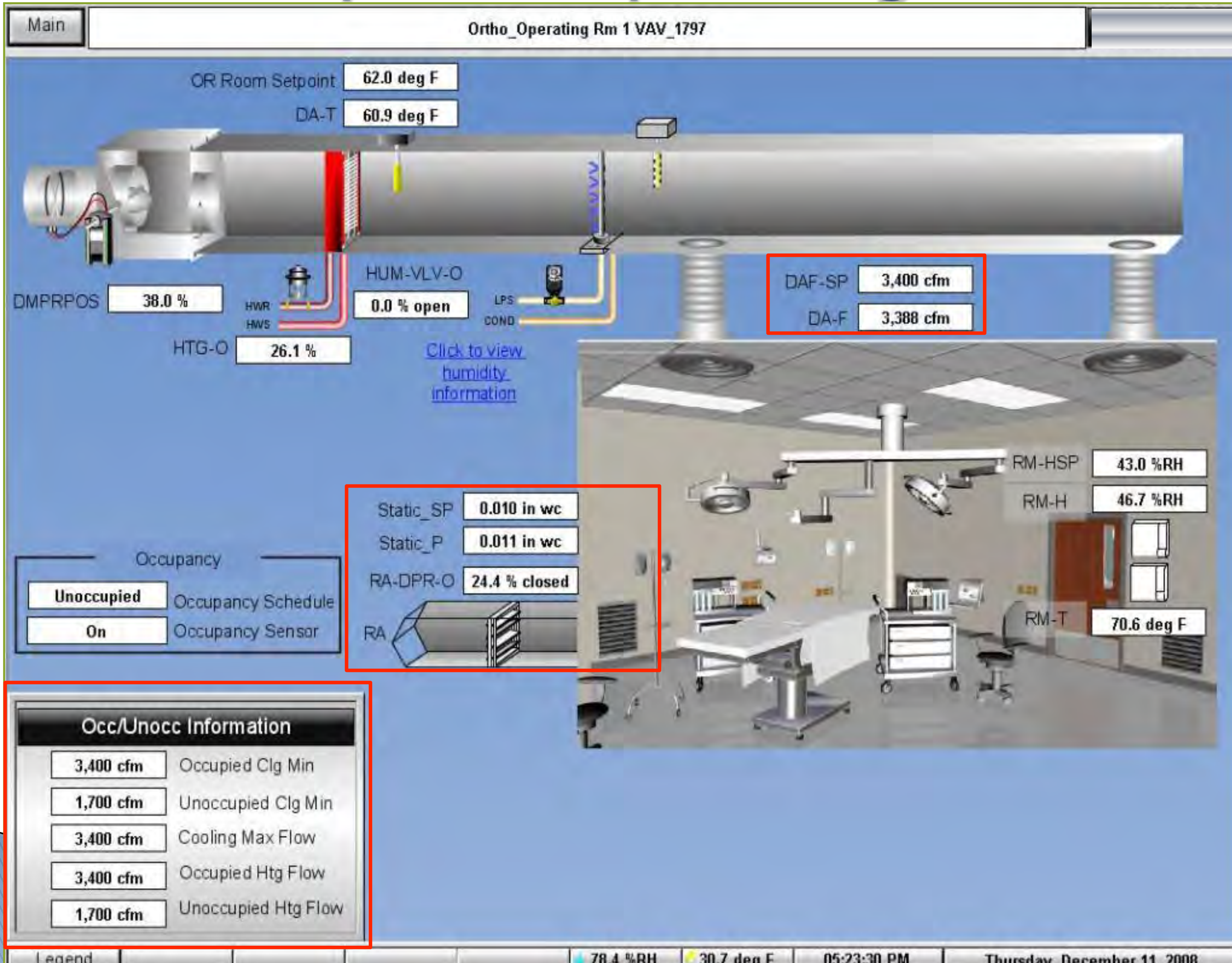
Case Study #5 – Operating Rooms

- Operating Room (OR) Design Details
  - 15 Operating Rooms
  - Temperature Range $\boxed{60°}$ – 78°F
  - Relative Humidity Range 40 – $\boxed{60}$ % RH
  - Occupied Mode – 30 Air Changes per Hour
  - Unoccupied Mode – 15 Air Changes per Hour
  - Supply VAV
  - Return Modulating Damper
  - Static Pressure Room Control

Case Study #5 – Humidification



Case Study #5 – Operating Rooms



Case Study #5 – OR Pressurization

- Operating Conditions
  - ORs were found going negatively pressurized during transition from occupied to unoccupied
  - 30 ACH to 15 ACH
  - Supply VAV box can decrease from occupied to unoccupied CFM in approx. 60 seconds
  - Return damper controlled by room pressure sensor takes 15 to 20 minutes to regain stable pressure control

Case Study #5 – OR Pressurization

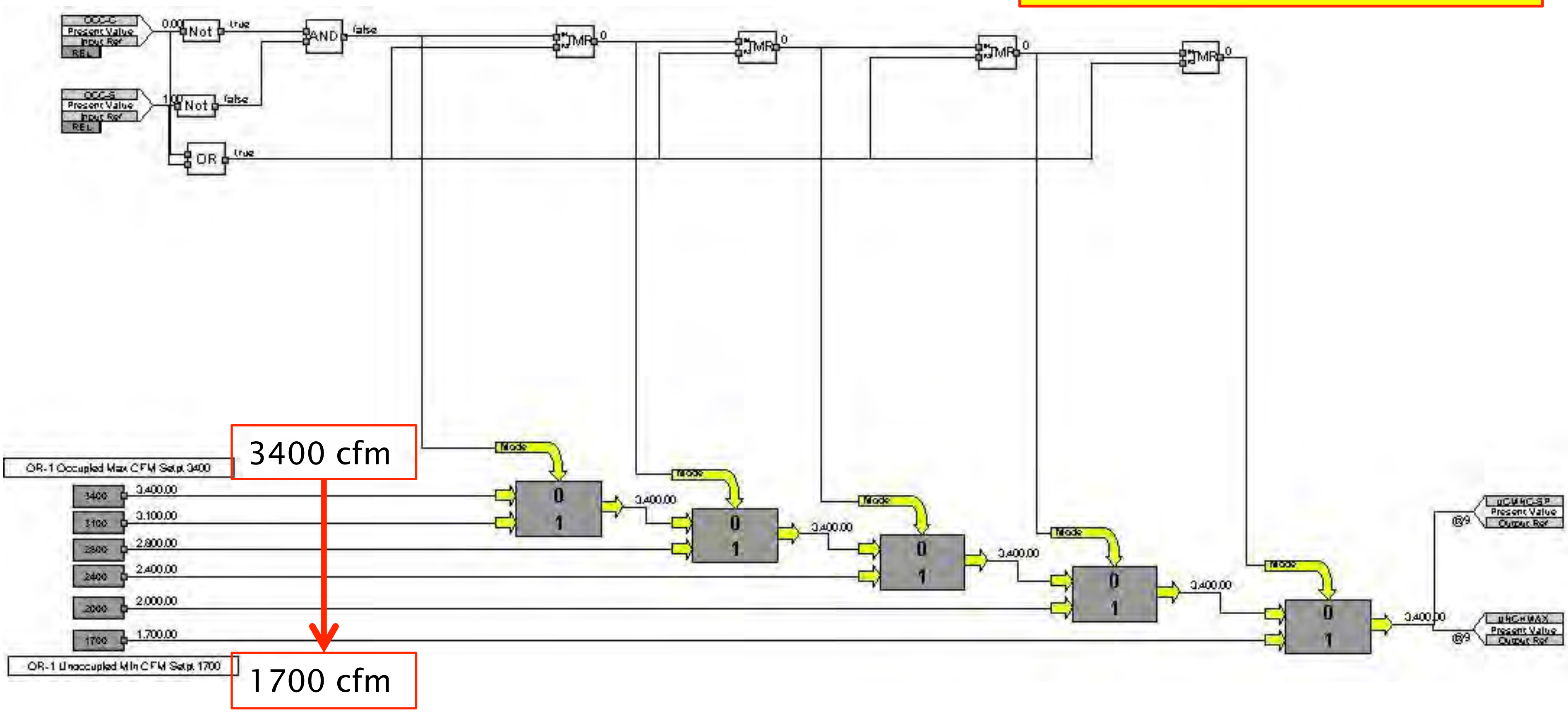
Time	OR1_VAV Discharge Air Flow (cfm)	OR1_VAV Room Static Pressure (in wc)	OR1_VAV Return Air Damper Position (% closed)	OR1_VAV Supply Damper Position (% Open)	OR1 Occupied Unoccupied Mode
3/11/09 10:27:00 PM CDT	3,373	0.023	0.5%	37.1%	Occupied
3/11/09 10:28:00 PM CDT	3,373	0.022	0.5%	37.1%	Occupied
3/11/09 10:29:00 PM CDT	3,354	0.022	0.5%	37.1%	Occupied
3/11/09 10:30:00 PM CDT	3,379	0.023	0.5%	37.1%	Occupied
3/11/09 10:31:00 PM CDT	3,382	0.021	0.5%	37.1%	Occupied
3/11/09 10:32:00 PM CDT	3,377	0.022	0.5%	37.1%	Occupied
3/11/09 10:33:00 PM CDT	1,608	0.014	1.0%	37.1%	Unoccupied
3/11/09 10:34:00 PM CDT	1,602	-0.028	6.5%	15.0%	Unoccupied
3/11/09 10:35:00 PM CDT	1,683	-0.028	10.0%	15.0%	Unoccupied
3/11/09 10:36:00 PM CDT	1,685	-0.025	14.9%	15.0%	Unoccupied
3/11/09 10:37:00 PM CDT	1,675	-0.023	18.7%	15.0%	Unoccupied
3/11/09 10:38:00 PM CDT	1,692	-0.021	22.8%	15.0%	Unoccupied
3/11/09 10:39:00 PM CDT	1,683	-0.018	25.0%	15.0%	Unoccupied
3/11/09 10:40:00 PM CDT	1,680	-0.016	28.4%	15.0%	Unoccupied
3/11/09 10:41:00 PM CDT	1,657	-0.014	31.2%	15.0%	Unoccupied
3/11/09 10:42:00 PM CDT	1,651	-0.014	32.7%	15.0%	Unoccupied
3/11/09 10:43:00 PM CDT	1,681	-0.010	35.9%	15.0%	Unoccupied
3/11/09 10:44:00 PM CDT	1,670	-0.009	38.4%	15.0%	Unoccupied
3/11/09 10:45:00 PM CDT	1,689	-0.007	39.5%	15.0%	Unoccupied
3/11/09 10:46:00 PM CDT	1,678	-0.006	40.9%	15.0%	Unoccupied
3/11/09 10:47:00 PM CDT	1,700	-0.003	42.9%	15.0%	Unoccupied
3/11/09 10:48:00 PM CDT	1,674	-0.003	44.2%	15.0%	Unoccupied
3/11/09 10:49:00 PM CDT	1,702	-0.002	45.4%	15.0%	Unoccupied
3/11/09 10:50:00 PM CDT	1,714	-0.001	46.5%	15.0%	Unoccupied
3/11/09 10:51:00 PM CDT	1,686	-0.001	47.7%	15.0%	Unoccupied
3/11/09 10:52:00 PM CDT	1,677	0.001	48.7%	15.0%	Unoccupied
3/11/09 10:53:00 PM CDT	1,699	0.001	49.4%	15.0%	Unoccupied
3/11/09 10:54:00 PM CDT	1,680	0.002	50.5%	15.0%	Unoccupied
3/11/09 10:55:00 PM CDT	1,685	0.003	51.0%	15.0%	Unoccupied
3/11/09 10:56:00 PM CDT	1,700	0.001	52.3%	15.0%	Unoccupied
3/11/09 10:57:00 PM CDT	1,724	0.012	52.3%	15.0%	Unoccupied
3/11/09 10:58:00 PM CDT	1,693	0.006	53.0%	15.0%	Unoccupied
3/11/09 10:59:00 PM CDT	1,719	0.011	53.0%	15.0%	Unoccupied

Negative OR Pressurization

Neutral OR Pressurization

Case Study #5 – OR Pressurization

RCx should help troubleshoot and offer results-based suggestions



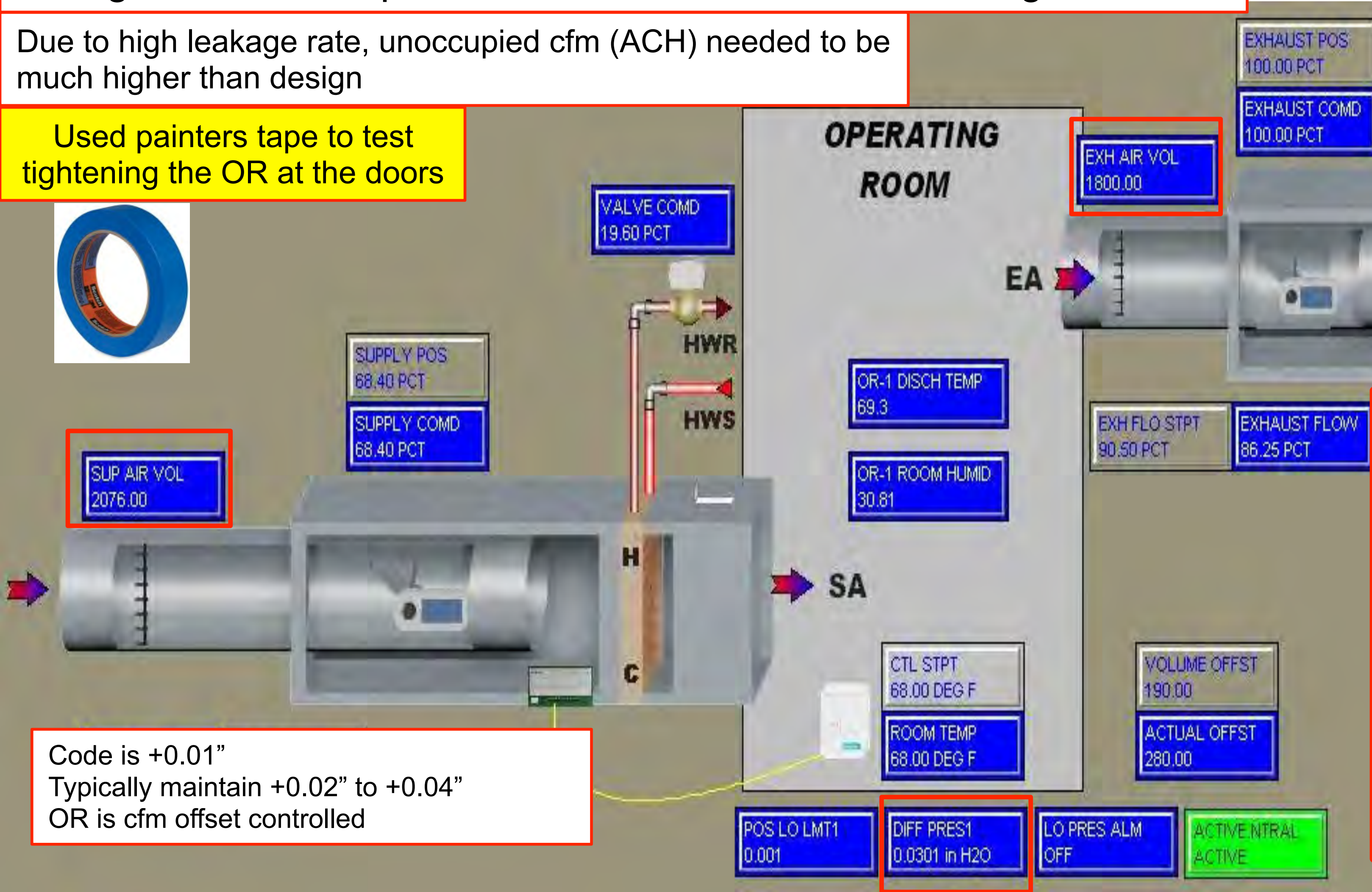
Added a stepped control loop to go from occupied to unoccupied mode in 300 cfm increments every five minutes

Case Study #6 – OR Controls, Construction and TAB

OR cfm offset = 2,076 - 1,800 = 276 cfm
ORs started with over 700 cfm offset due to no door sweeps or astragals and incomplete construction such as the med gas column

Due to high leakage rate, unoccupied cfm (ACH) needed to be much higher than design

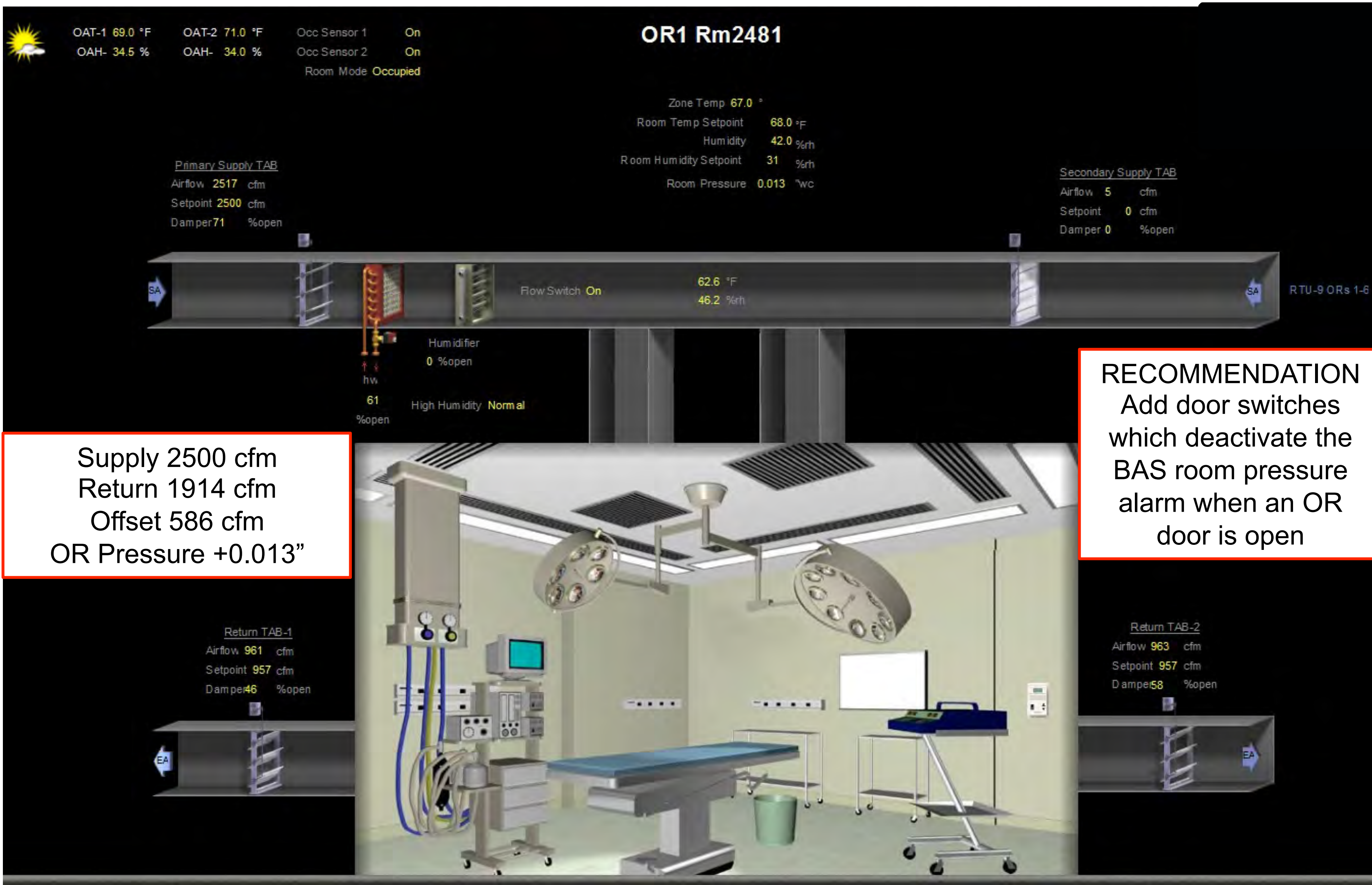
Used painters tape to test tightening the OR at the doors



Code is +0.01”
Typically maintain +0.02” to +0.04”
OR is cfm offset controlled

ADDED

Case Study #7 – Dual Supply and Return VAV Boxes



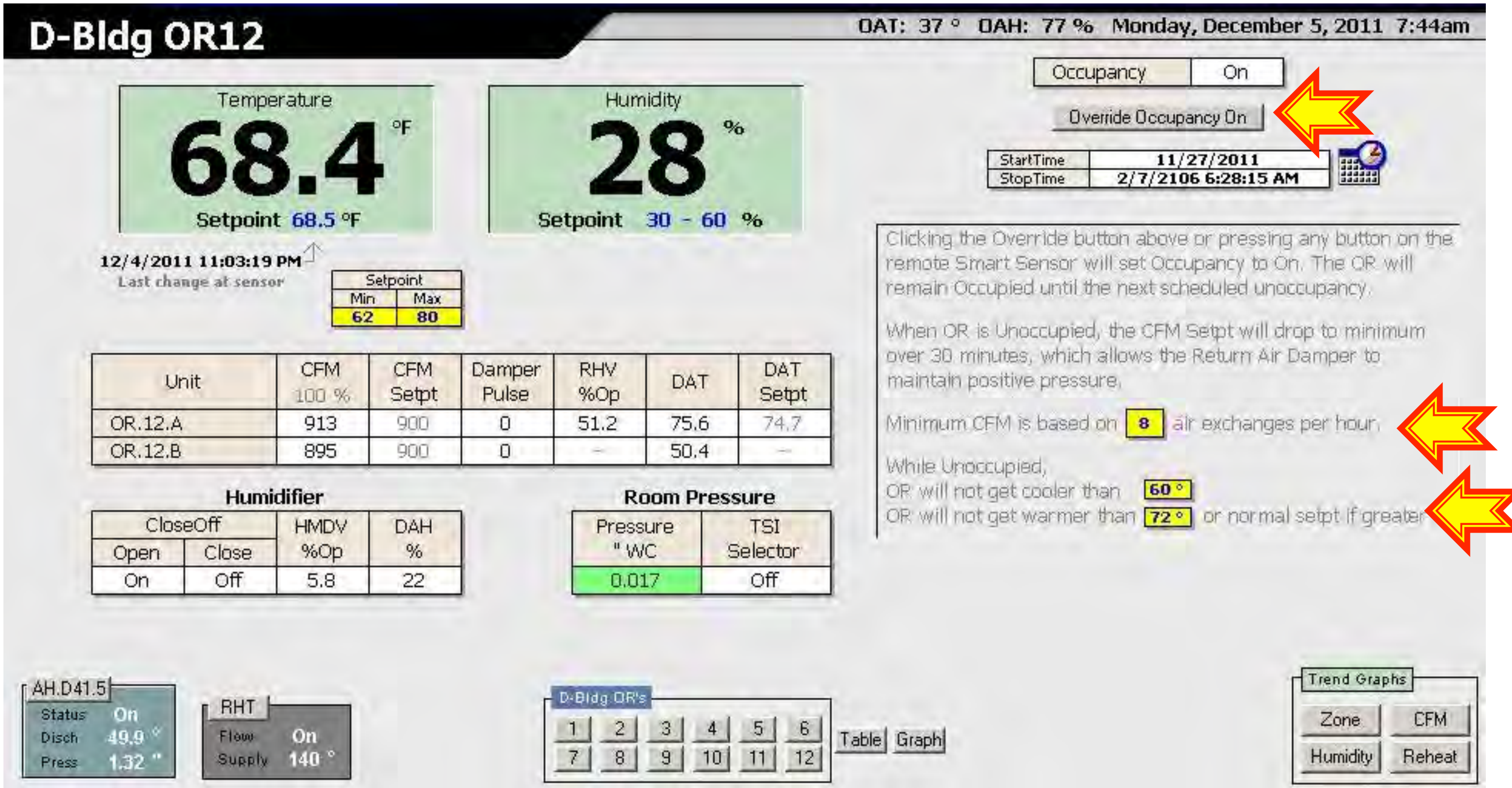
Supply 2500 cfm
Return 1914 cfm
Offset 586 cfm
OR Pressure +0.013”

RECOMMENDATION
Add door switches which deactivate the BAS room pressure alarm when an OR door is open

Case Study #8 – Unoccupied Mode for 12 ORs

- Four Operating Room AHUs each serving three ORs (12 total)
- Each AHU has supply and return fans with VFDs

Case Study #8 – Unoccupied Mode for 12 ORs



Most ORs can be positively pressurized with six to eight air changes per hour.
Let temperature "float" during unoccupied mode with deadband.

Case Study #8 – Unoccupied Mode for ORs 1 though 6

Date/Time	OR1.AirX	OR2.AirX	OR3.AirX	OR4.AirX	OR5.AirX	OR6.AirX
12/6/2011 2:44:00 P	-	-	-	-	-	-
12/6/2011 1:44:00 P	25.1	24.7	25.2	25.2	31.7	25.2
12/6/2011 12:44:00	25.2	24.8	25.4	25.3	31.7	25.3
12/6/2011 11:44:00	25.2	24.7	25.2	25.2	31.6	25.2
12/6/2011 10:44:00	25.0	24.8	25.4	25.2	31.8	25.0
12/6/2011 9:44:00 A	25.2	24.8	25.1	25.1	31.8	25.1
12/6/2011 8:44:00 A	25.2	24.9	25.3	25.2	31.8	25.2
12/6/2011 7:44:00 A	25.0	24.7	25.2	25.2	31.7	24.7
12/6/2011 6:44:00 A	25.0	25.0	23.3	18.7	32.0	8.3
12/6/2011 5:44:00 A	25.0	24.8	7.6	7.8	9.5	8.4
12/6/2011 4:44:00 A	25.3	24.7	7.6	7.7	7.7	8.4
12/6/2011 3:44:00 A	25.2	24.8	7.6	7.8	7.8	8.4
12/6/2011 2:44:00 A	25.0	24.8	7.6	7.8	7.9	8.3
12/6/2011 1:44:00 A	25.1	24.7	7.6	7.8	8.0	8.3
12/6/2011 12:44:00	25.4	24.7	12.2	12.4	14.3	12.8
12/5/2011 11:44:00	25.0	24.8	25.1	25.2	31.6	25.2
12/5/2011 10:44:00	25.1	24.8	25.2	25.3	31.6	25.2
12/5/2011 9:44:00 P	25.0	24.6	25.1	25.3	31.5	25.1
12/5/2011 8:44:00 P	25.1	24.7	25.1	25.1	31.8	25.2
12/5/2011 7:44:00 P	25.0	24.7	25.3	25.3	31.9	25.1
12/5/2011 6:44:00 P	24.9	24.7	25.3	25.2	31.9	25.3
12/5/2011 5:44:00 P	25.1	24.9	25.3	25.3	31.8	25.2
12/5/2011 4:44:00 P	25.1	24.9	25.4	25.2	31.8	25.4
12/5/2011 3:44:00 P	25.1	24.9	25.3	25.4	31.9	25.4
12/5/2011 2:44:00 P	25.1	24.8	25.2	25.2	31.8	25.2

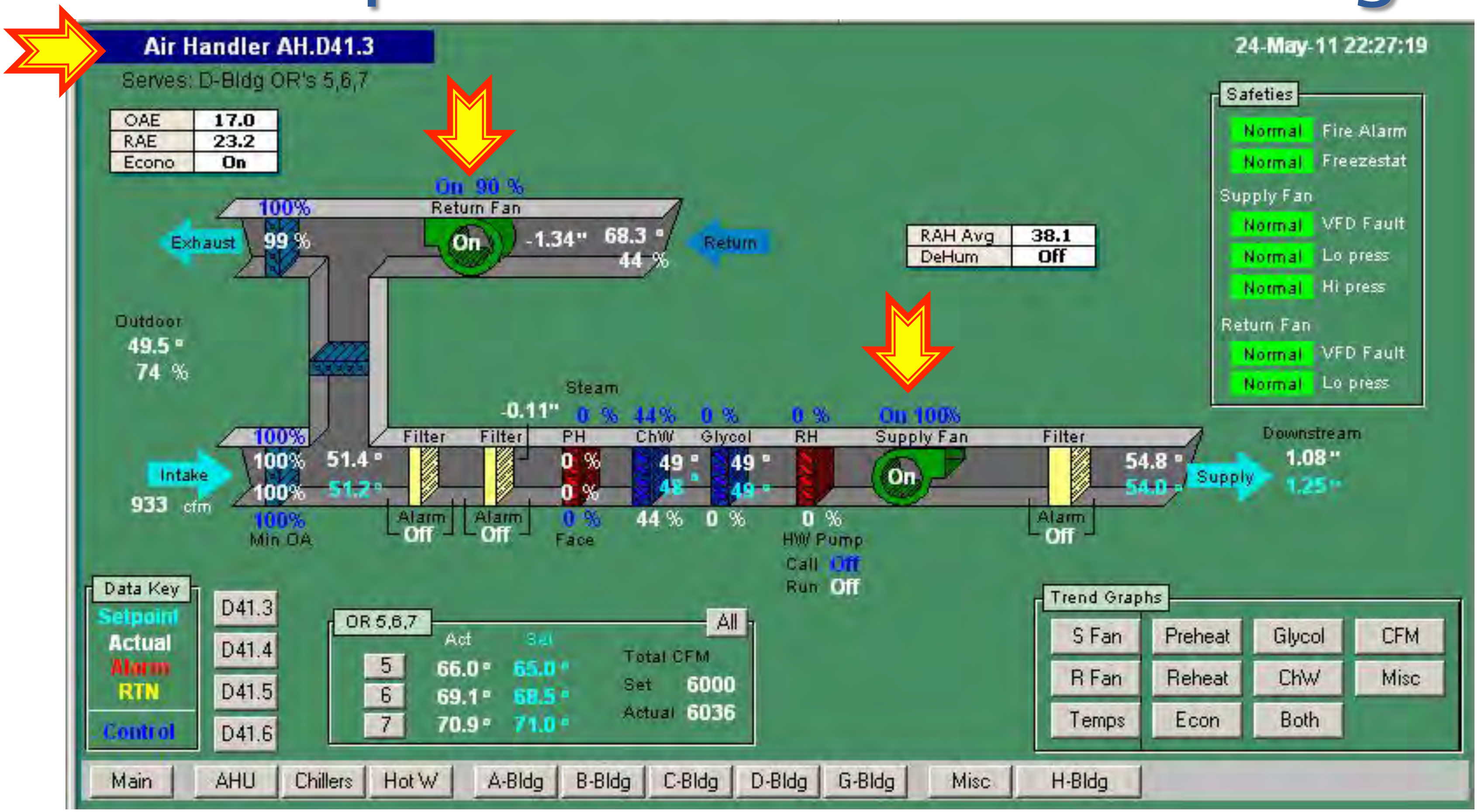
Hospital with Level 1 Trauma Center. Four ORs were decided to be left occupied all the time: ORs 1,2, 11 and 12 (also the biggest)

Case Study #8 – Unoccupied Mode for ORs 7 though 12

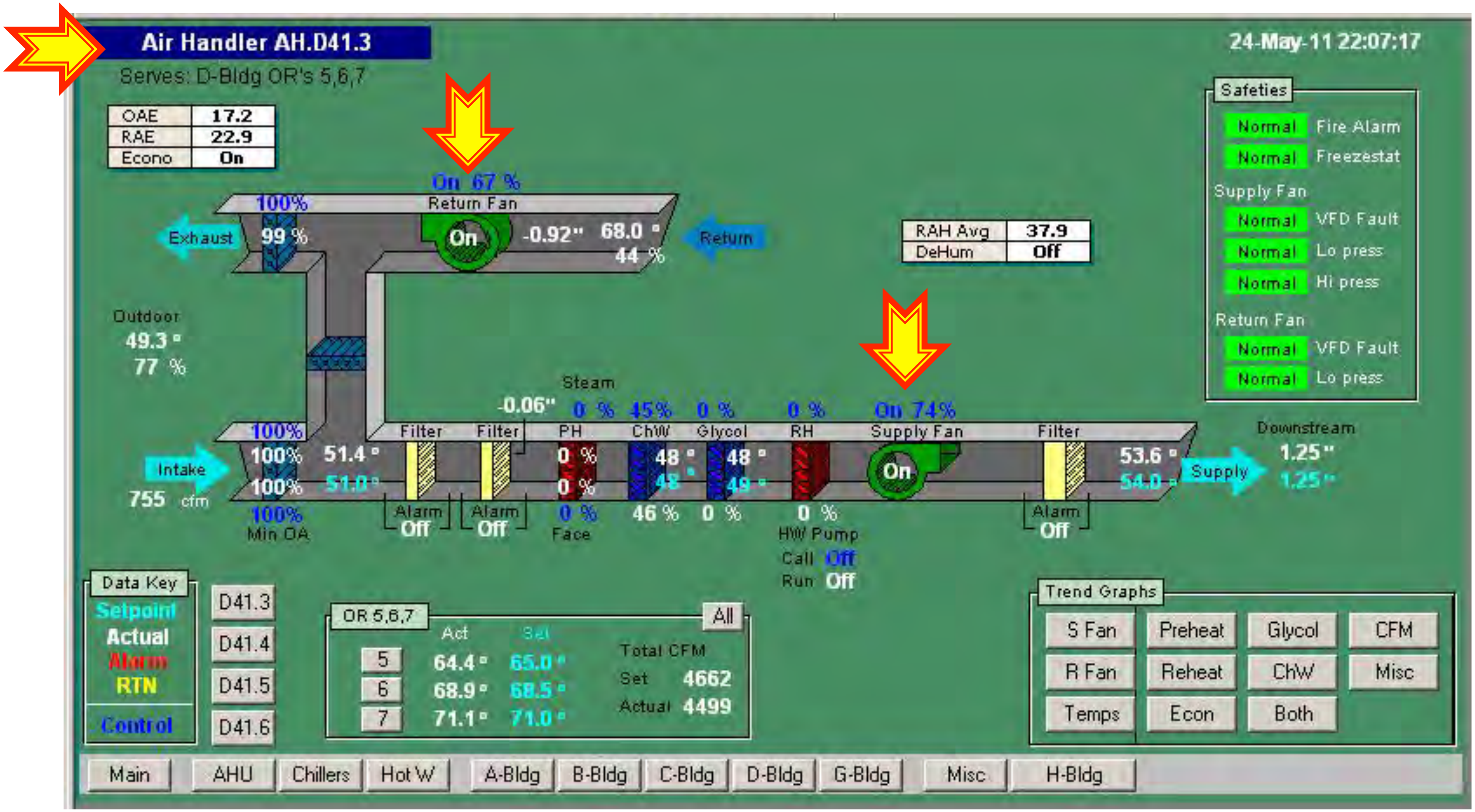
Date/Time	OR7.AirX	OR8.AirX	OR9.AirX	OR10.AirX	OR11.AirX	OR12.AirX
12/6/2011 2:45:00 P	-	-	-	-	-	-
12/6/2011 1:45:00 P	25.2	25.4	25.3	25.2	25.3	25.1
12/6/2011 12:45:00	25.2	25.3	25.3	25.2	25.3	25.1
12/6/2011 11:45:00	25.2	25.2	25.2	25.3	25.3	25.1
12/6/2011 10:45:00	25.1	25.2	25.2	25.1	25.3	25.1
12/6/2011 9:45:00 A	25.2	25.2	25.4	25.2	25.4	25.2
12/6/2011 8:45:00 A	25.1	25.3	25.3	25.1	25.4	25.1
12/6/2011 7:45:00 A	24.8	24.8	25.0	25.2	25.3	25.0
12/6/2011 6:45:00 A	12.0	6.8	8.2	25.1	25.3	25.1
12/6/2011 5:45:00 A	11.7	6.8	8.2	25.2	25.2	25.1
12/6/2011 4:45:00 A	11.8	6.8	8.2	25.1	25.3	25.1
12/6/2011 3:45:00 A	11.8	6.8	8.3	25.2	25.4	25.2
12/6/2011 2:45:00 A	11.8	6.8	8.3	8.0	25.3	25.0
12/6/2011 1:45:00 A	11.8	6.8	8.2	7.7	25.3	25.1
12/6/2011 12:45:00	14.9	11.7	12.7	12.5	25.5	25.2
12/5/2011 11:45:00	25.2	25.1	25.3	25.1	25.4	25.1
12/5/2011 10:45:00	25.2	25.2	25.4	25.1	25.4	25.1
12/5/2011 9:45:00 P	25.1	25.0	25.2	25.1	25.2	25.0
12/5/2011 8:45:00 P	24.9	25.3	25.3	25.1	25.4	25.1
12/5/2011 7:45:00 P	24.9	25.2	25.2	25.1	25.2	25.1
12/5/2011 6:45:00 P	25.1	25.2	25.3	25.2	25.2	25.1
12/5/2011 5:45:00 P	25.1	25.3	25.3	25.2	25.4	25.1
12/5/2011 4:45:00 P	25.0	25.3	25.3	25.3	25.3	25.1
12/5/2011 3:45:00 P	25.1	25.2	25.3	25.2	25.5	25.1
12/5/2011 2:45:00 P	25.2	25.2	25.3	25.2	25.3	25.1

California Mechanical Code allows a *MINIMUM* of 6 ACH; it is not recommended or typically feasible to go below this

Case Study #8 – Unoccupied Mode BEFORE Changes



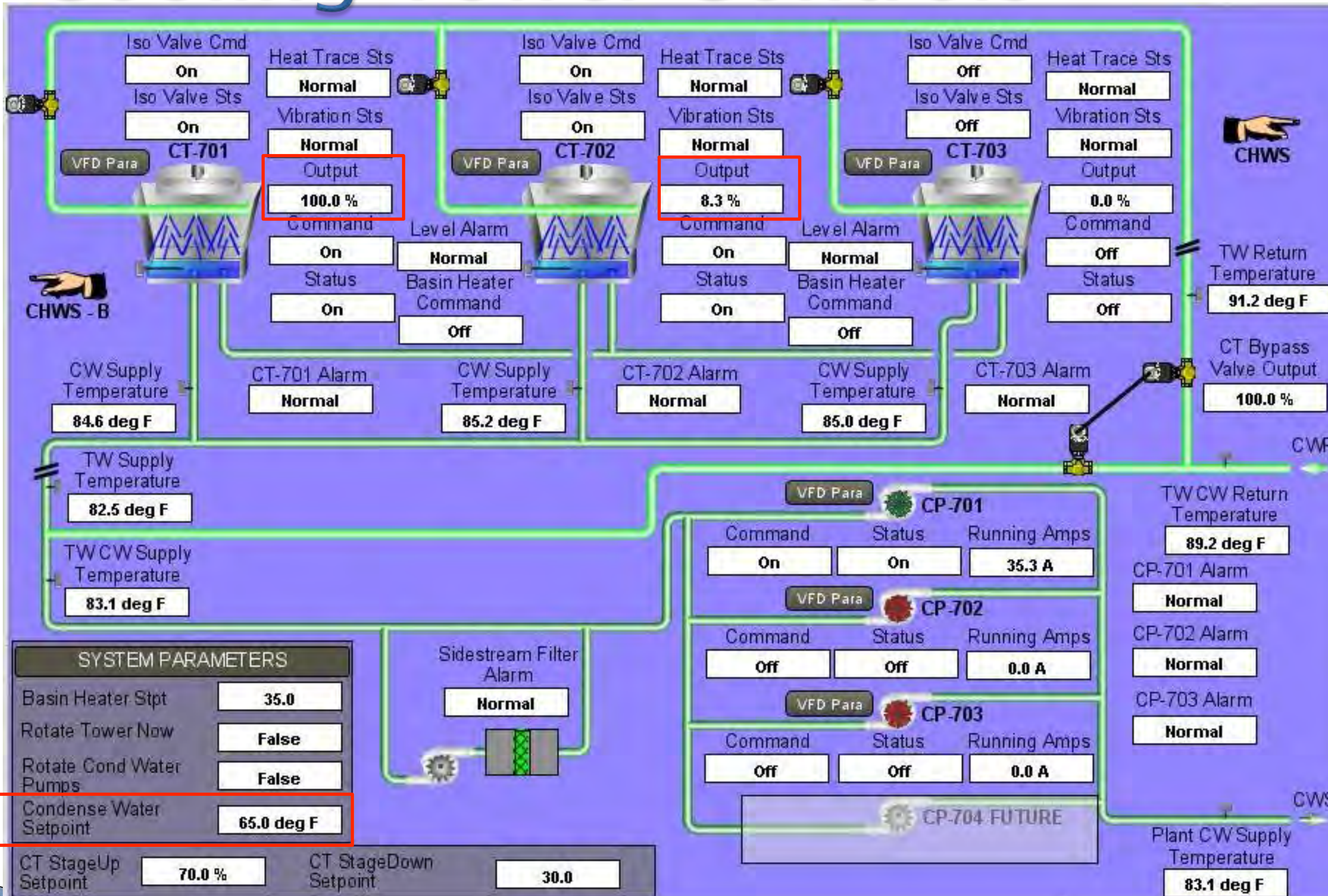
Case Study #8 – Unoccupied Mode AFTER Changes



Complications in Healthcare HVAC Systems

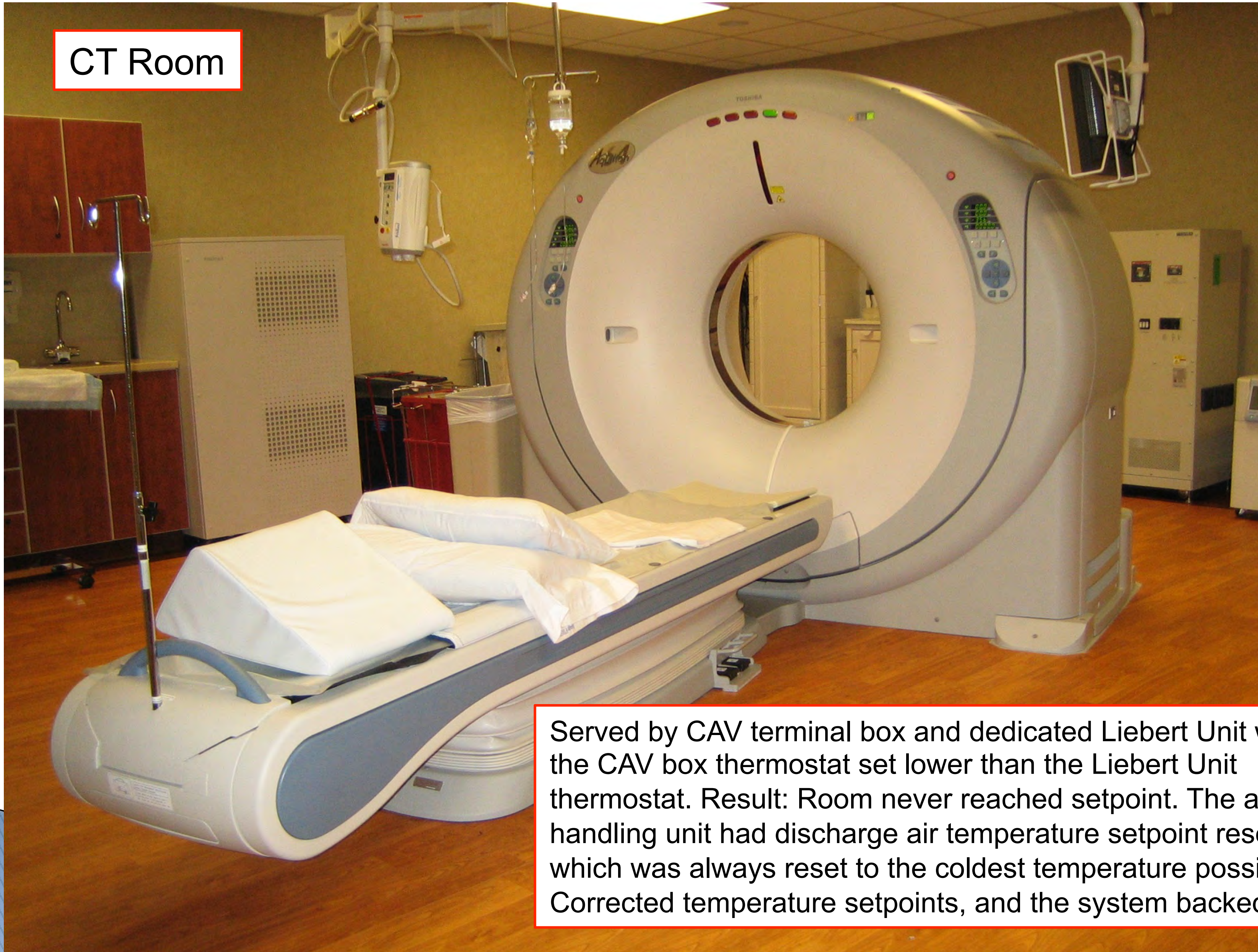
More complications than you think . . .

Cooling Tower Controls



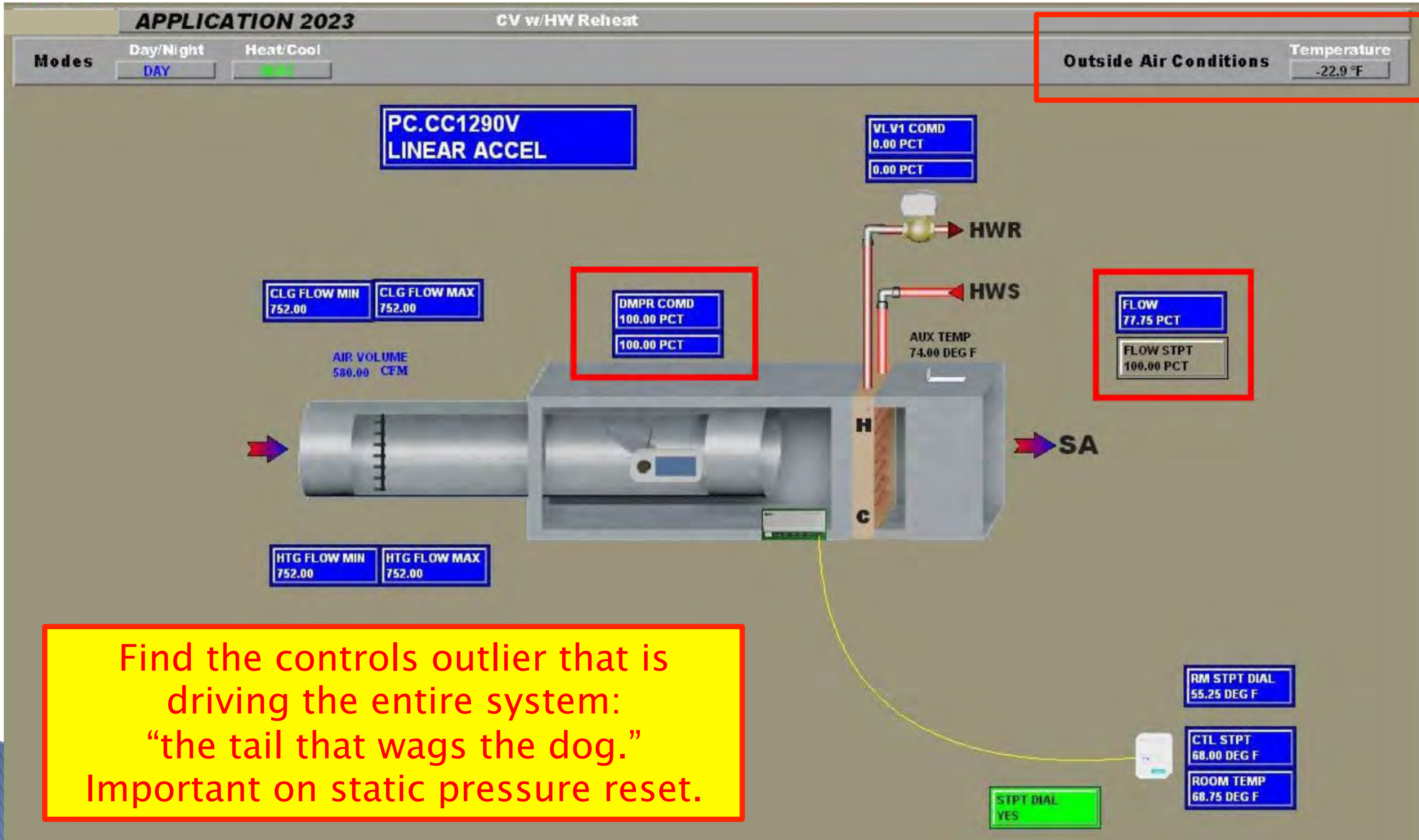
CW setpoint is very low, originally forcing all three CTs on, which caused CW flow to be below minimum on each tower. Reprogrammed to only allow two towers to operate with one chiller, but still have unequal loading. Problem with controls programming.

It's All in the Controls: Find the (Outlier)



Served by CAV terminal box and dedicated Liebert Unit with the CAV box thermostat set lower than the Liebert Unit thermostat. Result: Room never reached setpoint. The air handling unit had discharge air temperature setpoint reset, which was always reset to the coldest temperature possible. Corrected temperature setpoints, and the system backed off.

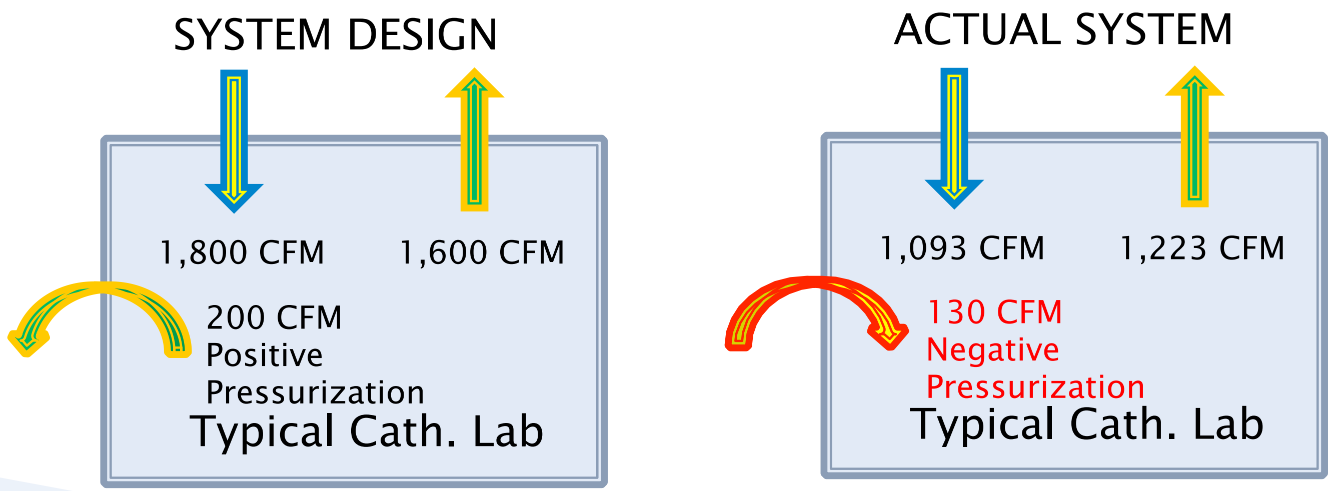
Find the Outlier & RCx



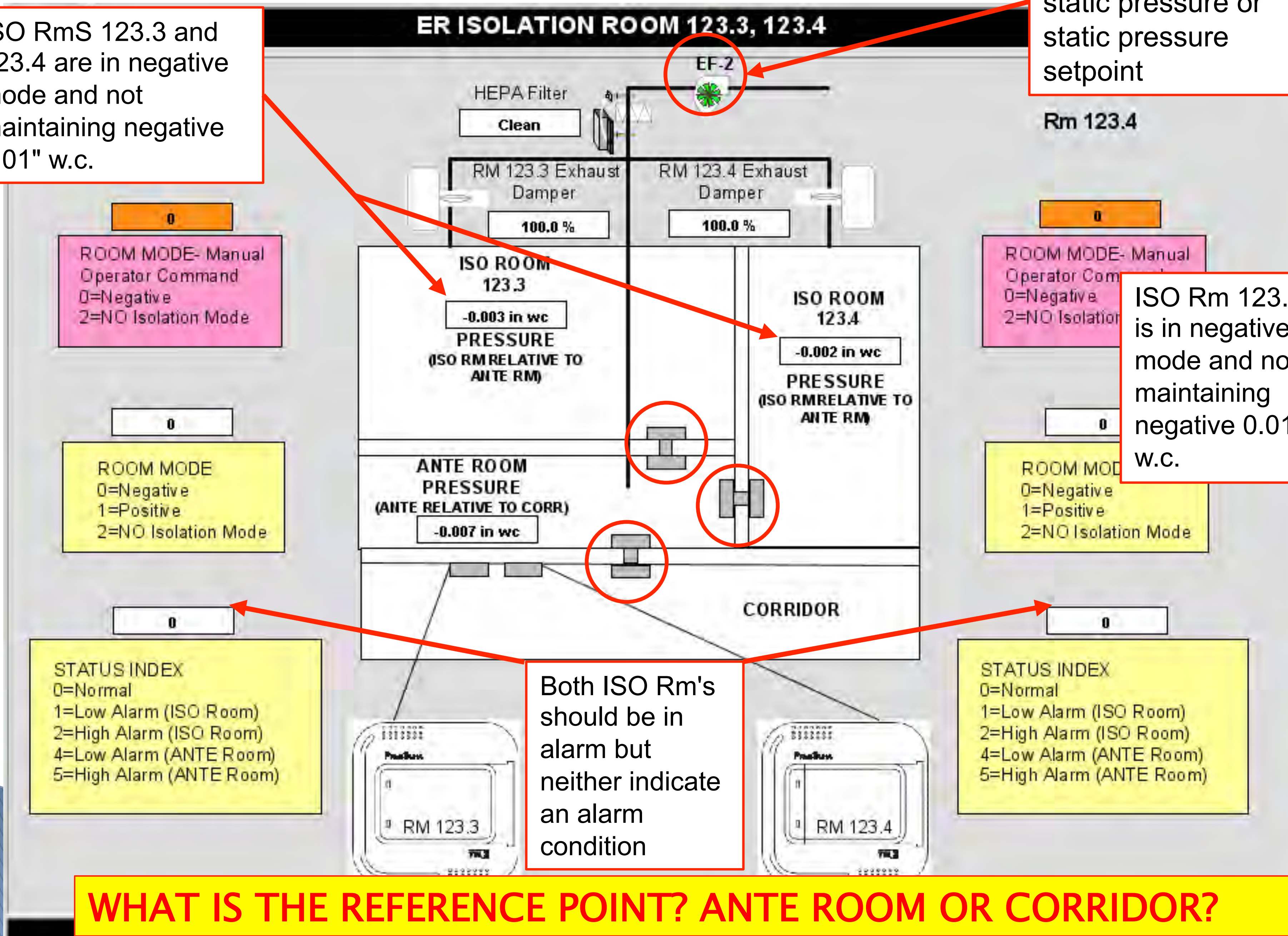
Find the controls outlier that is driving the entire system:
“the tail that wags the dog.”
Important on static pressure reset.

Room Pressurization

- Cardiac Catheterization Labs
  - Canned AHU controls programming used.
  - Airflow stations not set up properly or calibrated.
  - Fan tracking never set up.
  - Airflow at rooms' constant volume boxes not balanced.



Isolation Rooms



ISO RmS 123.3 and 123.4 are in negative mode and not maintaining negative 0.01" w.c.

No data on EF-2 is shown, VFD speed, static pressure or static pressure setpoint

ISO Rm 123.4 is in negative mode and not maintaining negative 0.01" w.c.

Both ISO Rm's should be in alarm but neither indicate an alarm condition

WHAT IS THE REFERENCE POINT? ANTE ROOM OR CORRIDOR?

Operational Suggestions

- The most efficient hospitals in the benchmarking survey *leverage* the building automation controls system (BAS)
- How do you *leverage* the controls system?
  - Morning Report
  - Trending
  - Alarming (Be careful not to alarm everything!)
  - Review and manage *overridden* points
  - Keep a journal log of problems and overrides for the controls service contractor
  - Review setpoints and outliers ⇒ OPTIMIZE sequences

Operational Suggestions

- Overridden Points
  - Review all current overridden points with an intent to release the override
  - Investigate why points are overridden
  - Require documentation when overriding points in the controls journal
- Start a root cause analysis program to reduce repeat hot/cold calls.
  - Identify rooms, areas or units with three or more complaints in a short period of time
  - Determine if there is a mechanical equipment problem or controls problem

Operational Suggestions

- Establish realistic temperature and humidity operating conditions
  - Are systems/equipment operating outside their design parameters?
  - Has the space usage/load changed?
- Setpoints and Outliers
  - Why is the discharge air temperature 55° all year?
  - Why is the static pressure setpoint on most air handlers set to 1.5” w.g.?

AND don’t forget to look at your OR fans once in a while . . .

Thank You – Questions

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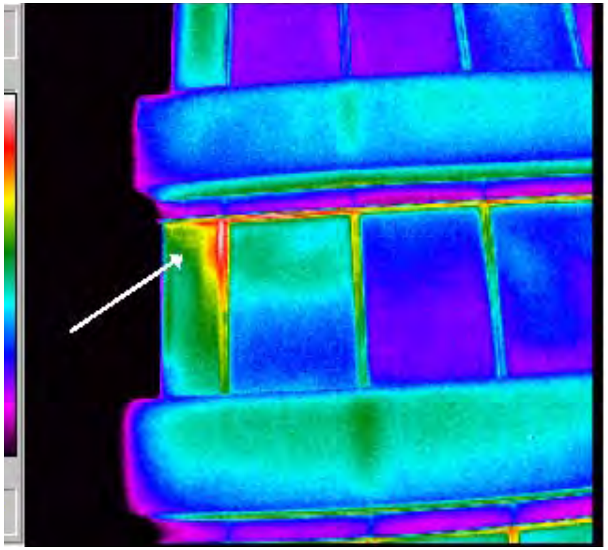
Plugging Leaks- Building

Air Infiltration

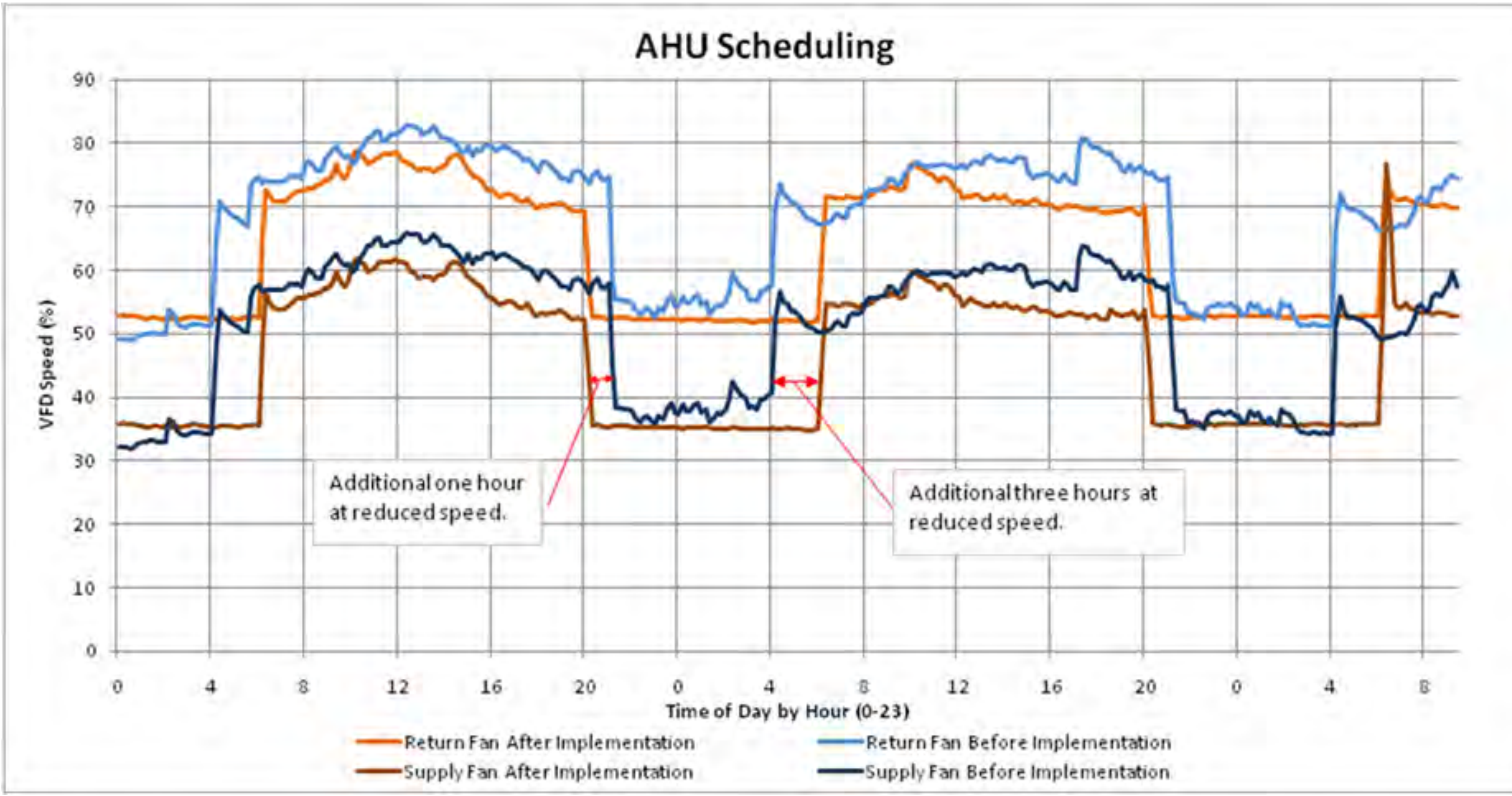


The windows of this office building may look fine to the naked eye, but a thermograph readily revealed leaky window sealant.

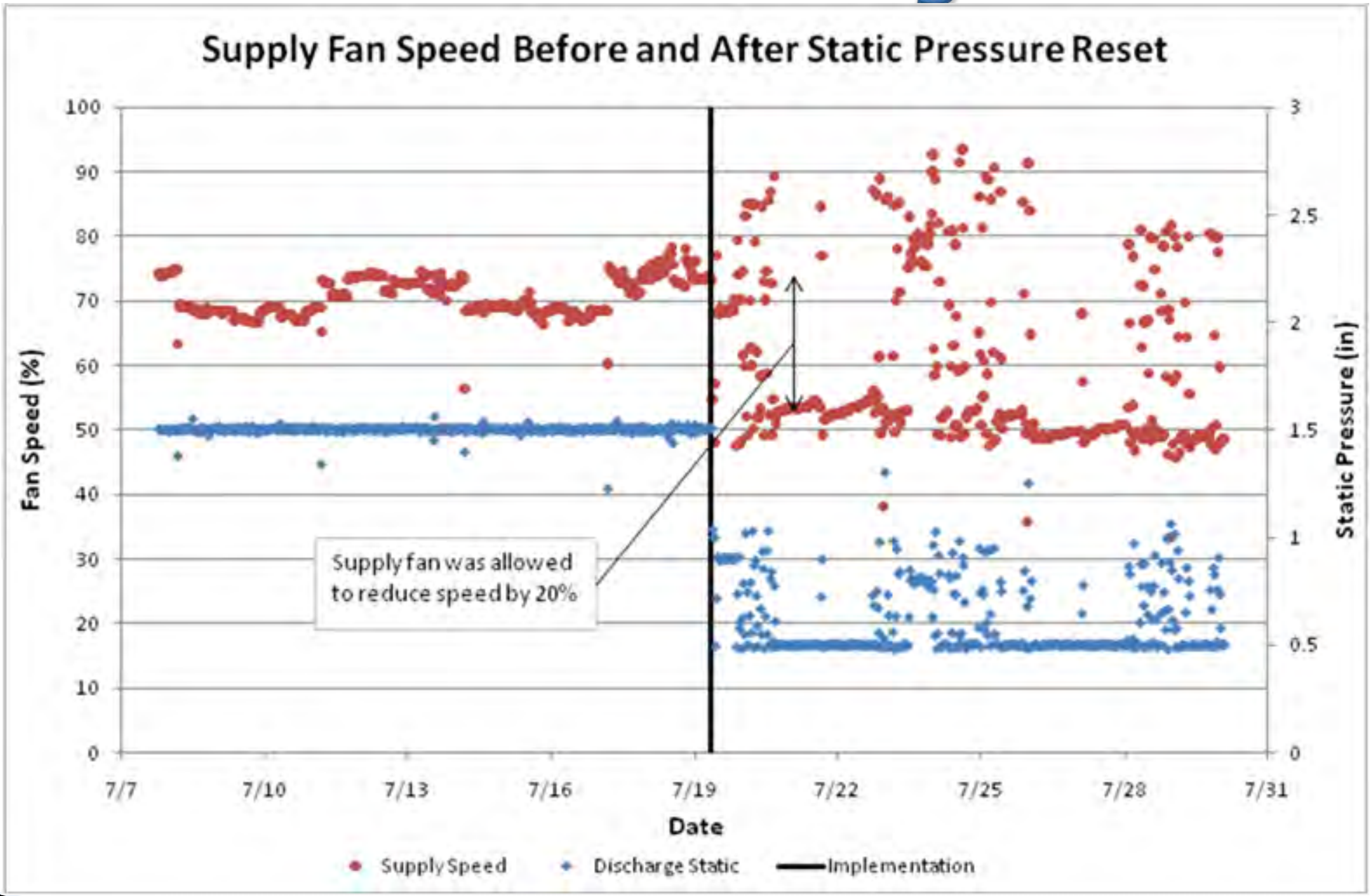
Plugging Leaks- Steam System

Leaking steam trap on the left

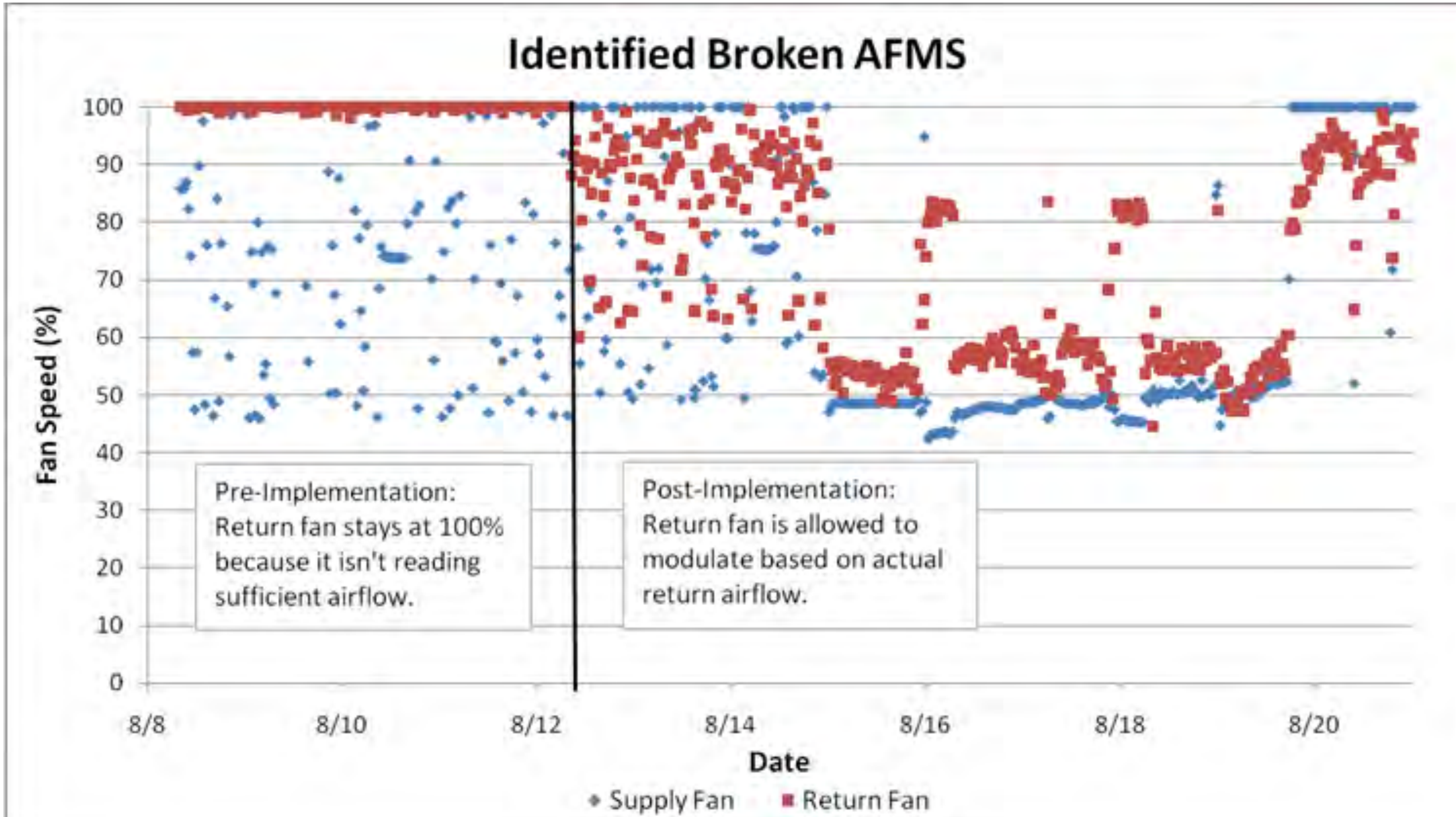
Retro-Commissioning



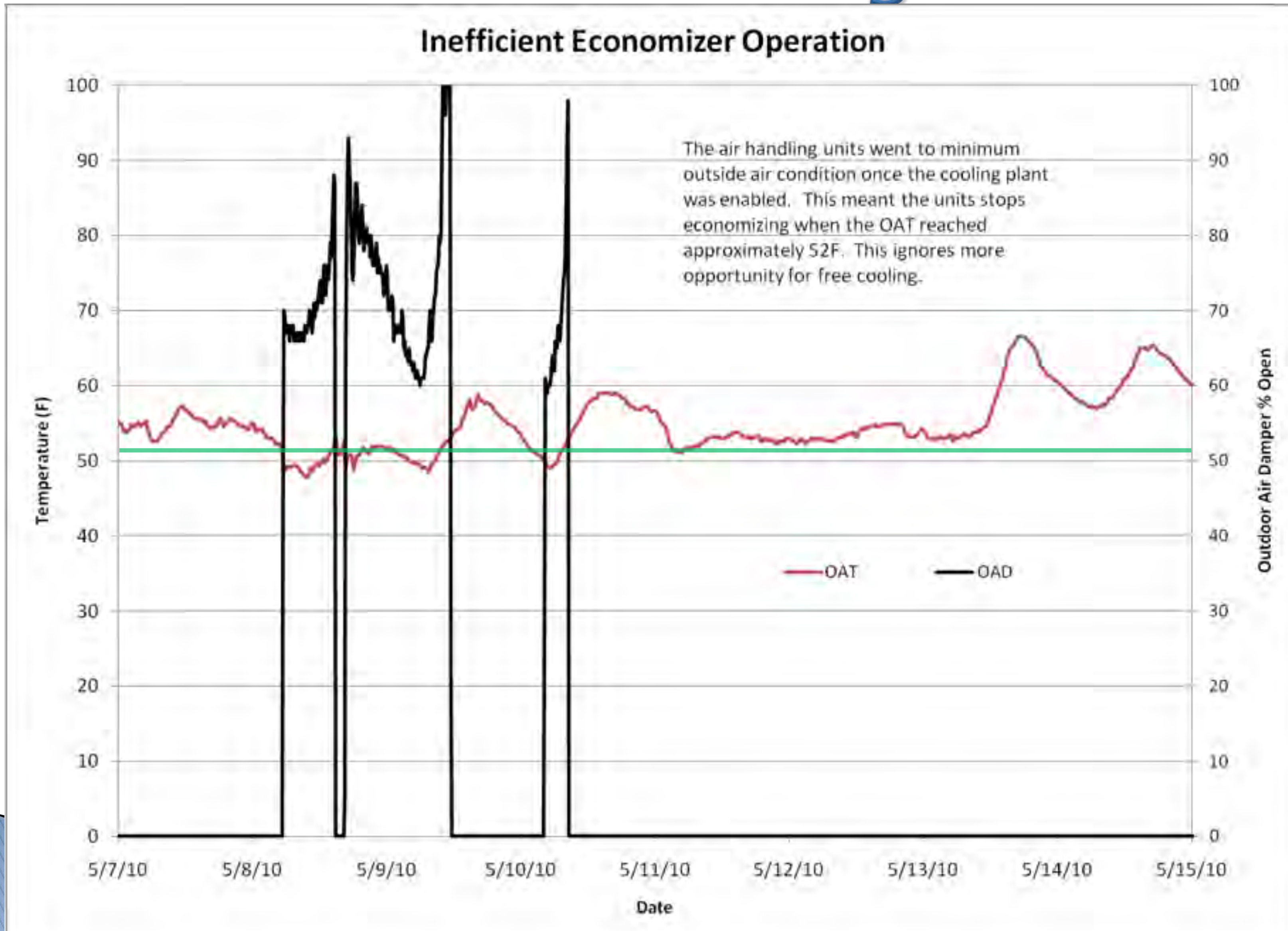
Retro-Commissioning



Retro-Commissioning



Retro-Commissioning



Stairwell Pressurization

- High-Rise Code
  - Need input from AHJ on design
  - Need input from Fire Department on how they test
  - IMC .15” to .35” w.g.
  - Door Pull Test 30lb maximum
  - Need to functional performance test!
-

Complications in Healthcare HVAC Systems

Pandemic (Mass Casualty) Mode

MASS CASUALTY MODE OF OPERATION: (RTU-5, 6, 7 & 8)
MASS CASUALTY MODE SHALL BE ENABLED/DISABLED VIA A MANUAL GRAPHICAL SELECTION SWITCH FROM THE FMCS OPERATOR WORKSTATION. GRAPHICAL SWITCH SHALL BE DISPLAYED ON THE MAIN AHU SCREEN OF THE RESPECTIVE UNIT. MASS CASUALTY MODE SHALL BE ENABLED ONLY AFTER THE FMCS OPERATOR "CONFIRMS" THEY WANT TO ENTER MASS CASUALTY MODE. ONCE ENABLED THE FOLLOWING SHALL OCCUR:

- MASS CASUALTY RETURN DAMPER SHALL FULLY CLOSE & MASS CASUALTY EXHAUST DAMPER SHALL FULLY OPEN.
- RESPECTIVE MASS CASUALTY EXHAUST FAN SHALL BE ENERGIZED AFTER A 10 SECOND (ADJ.) DELAY TO PREVENT EXHAUST FAN FROM STARTING AGAINST CLOSED INLET DAMPER.

WHEN MASS CASUALTY MODE IS DISABLED THE FOLLOWING SHALL OCCUR:

- RESPECTIVE MASS CASUALTY EXHAUST FAN SHALL BE DE-ENERGIZED.
- MASS CASUALTY RETURN DAMPER SHALL FULLY OPEN & MASS CASUALTY EXHAUST DAMPER SHALL FULLY CLOSE.

Make sure to include special modes of operation in the RCx planned testing.

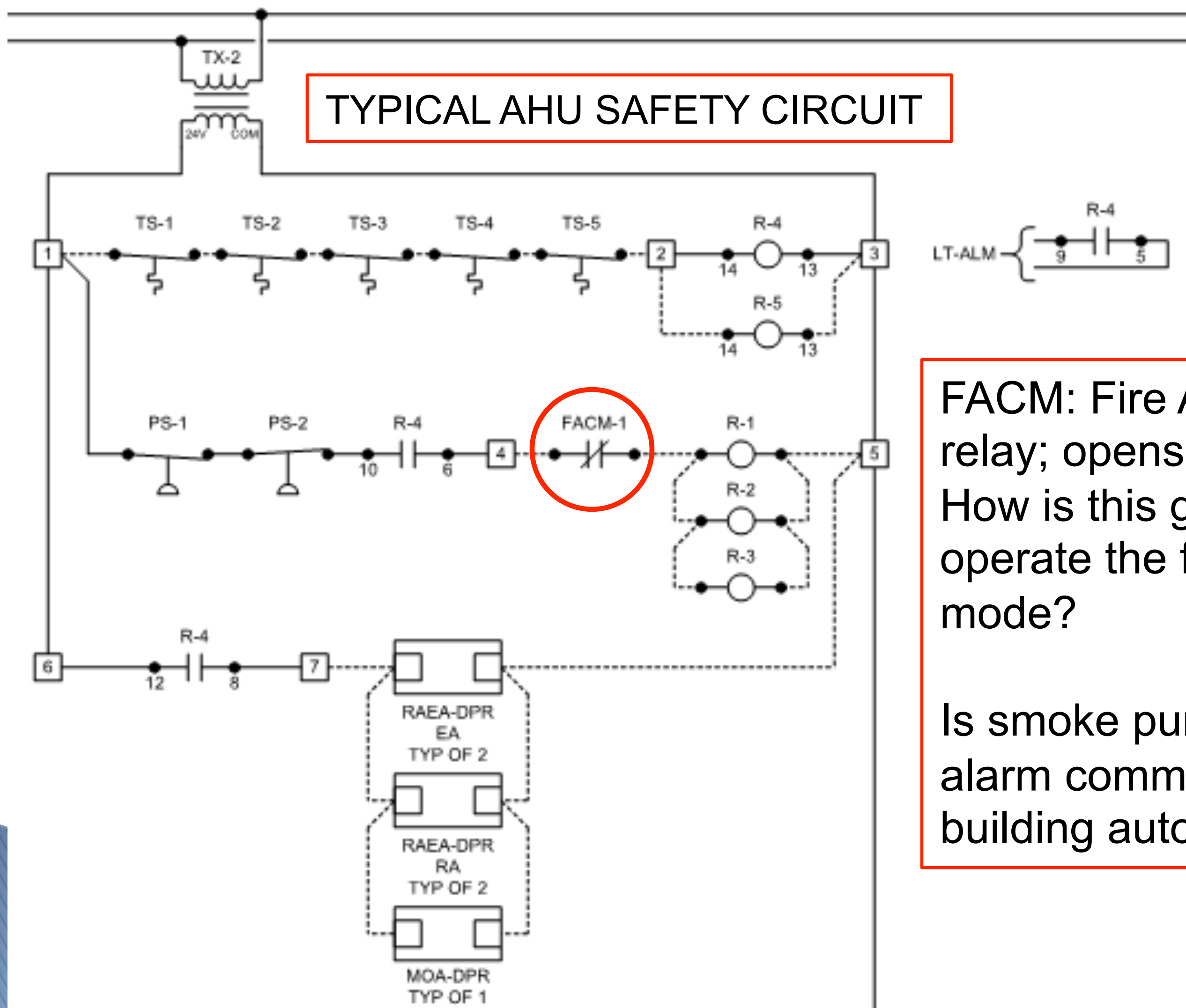
Complications in Healthcare HVAC Systems

SMOKE PURGE MODE TEST THIS MODE!!

Upon an alarm for smoke within the area served, the DDC will close the AHU return air damper and open the outside air and relief dampers for smoke purge. If smoke is detected in the supply discharge duct, the supply can shut down, *but the return fan should continue to operate.*

(How do you override the return duct detector?)

Complications in Healthcare HVAC Systems



FACM: Fire Alarm Command Module relay; opens during smoke event. How is this going to be bypassed to operate the fan in smoke purge mode?

Is smoke purge operated via the fire alarm command station or the building automation system?

Complications in Healthcare HVAC Systems

100% OA Mode

<u>EMERGENCY DEPARTMENT 100% OUTSIDE AIR MODE OF OPERATION:</u> (AHU-14)
100% OUTSIDE AIR MODE FOR THE ED SHALL BE ENABLED/DISABLED VIA A MANUAL GRAPHICAL SELECTION SWITCH FROM THE FMCS OPERATOR WORKSTATION. GRAPHICAL SWITCH SHALL BE DISPLAYED ON THE MAIN AHU SCREEN FOR AHU-14. 100% OUTSIDE AIR MODE SHALL BE ENABLED ONLY AFTER THE FMCS OPERATOR "CONFIRMS" THEY WANT TO ENTER MASS CASUALTY MODE. ONCE ENABLED THE FOLLOWING SHALL OCCUR:

- AHU-14 RELIEF AIR AND ECONOMIZER O.A. DAMPERS SHALL FULLY OPEN
- AHU-14 RETURN AIR DAMPERS SHALL FULLY CLOSE

WHEN 100% OUTSIDE AIR MODE FOR THE ED IS DISABLED THE FOLLOWING SHALL OCCUR:

- AHU-14 RELIEF AIR, RETURN AIR AND ECONOMIZER O.A. DAMPERS SHALL BE CONTROLLED IN ACCORDANCE WITH THE AHU-A SEQUENCE OF OPERATION.

Are heating/cooling coils sized for this mode?

Seasonal testing is a must!!
You cannot simulate air stratification through an air handling unit!!

Complications in Healthcare HVAC Systems

Backup (Cross-Over) Mode

Isolation Mode:

a. If an AHU is off due to emergency or maintenance operations, the smoke/isolation dampers shall close and the crossover damper shall open, allowing the other AHU to provide airflow to all terminal air boxes.

Is the cross-over mode initiated automatically or manually ???