Fun With Data

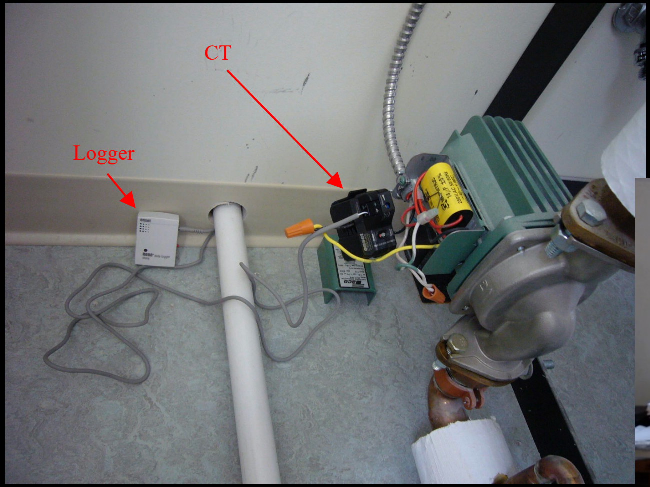
	DP(°F) : RTU In(return air/mixed air):1	DP(°F) : RTU Out(supply air):2	T(°F) : Theater	T(°F) : Outdoor Air	DP(°F) : Outdoor Air	T(°F) : Theater Floor	%RH : Theater Floor
min	61.30	58.80	66.20	69.50	67.30	67.80	82.20
max	70.60	71.20	73.00	85.10	76.00	70.10	92.20
diff	9.30	12.40	6.80	15.60	8.70	2.30	10.00

PHIUSCON 2021

Marc Rosenbaum, PE, CPHC, MA CSL – Energysmiths – West Tisbury, MA

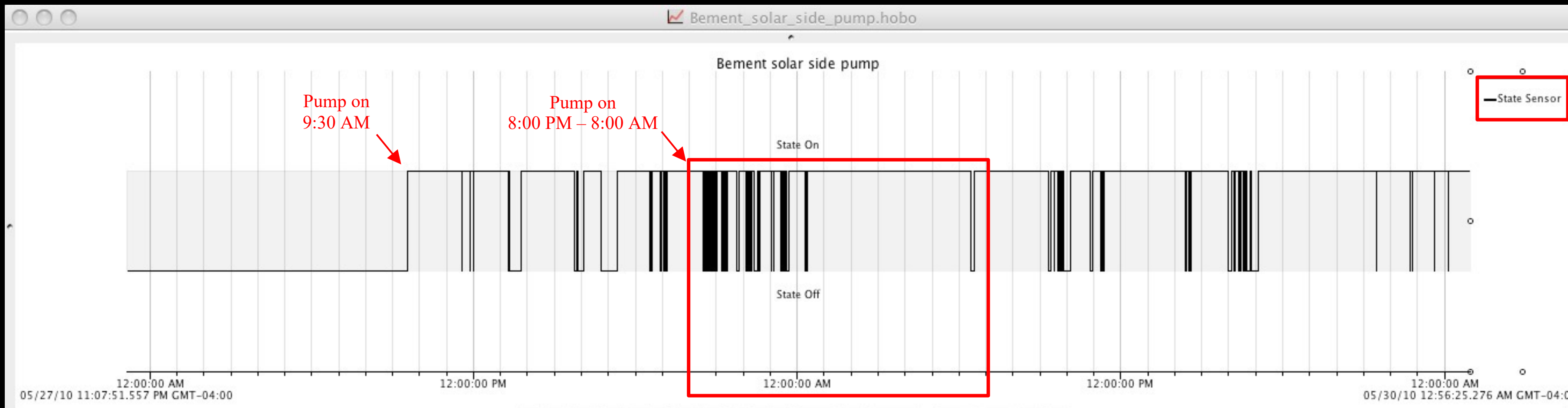
The Case of the High Hot Water Energy

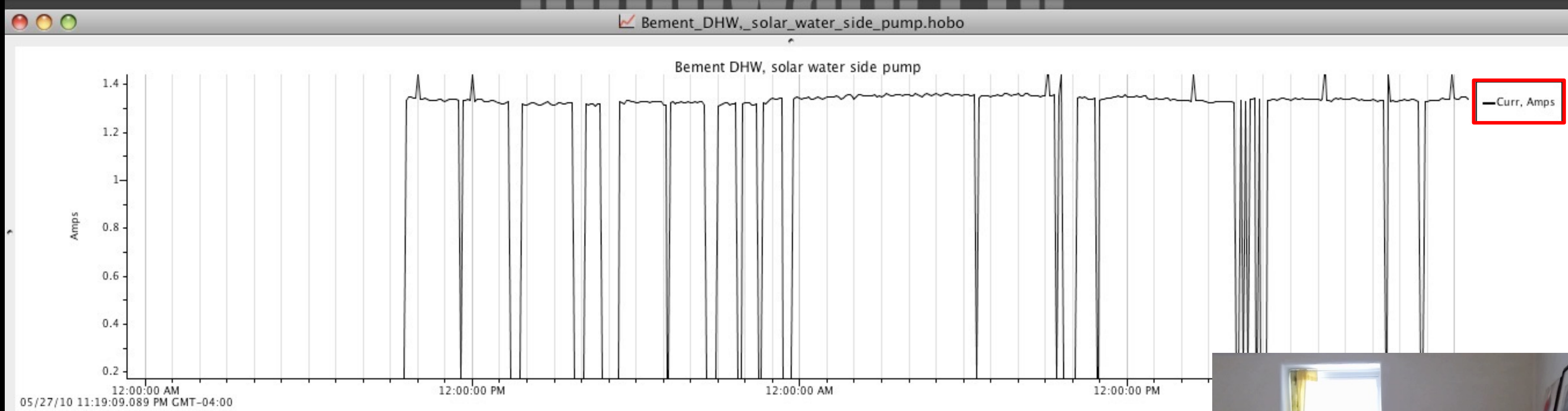
- 10,000 sf dorm – 4 faculty apartments, 10 double dorm rooms – 28 occupants
- 240 sf drainback SDHW system – two 120 gallon solar storage tanks with 120 gallon electric back-up
- Monitoring showed that back-up electric energy was higher than expected, while DHW usage was in line with modeled usage
- Installed Hobo dataloggers with current transformers on the solar array pump and on the potable side pump, as well as on the heating elements in the back-up tank



Marc Rosenbaum, PE – Energys

The Case of the High Hot Water Energy





The pumps were running at night – controller was faulty.
These are *solar* hot water systems, not *lunar* hot water systems

The Case of the Moldy Theater

- 270 seat black box theater in coastal MA
- Mold on seats and stage curtain
- RH over 80% in cooling season
- 10,000 CFM constant volume air handler with 4 stages of compressor modulation available
- Outdoor air was set to a maximum of 2,850 CFM and a minimum of 540 CFM with no energy recovery.
- To avoid over-cooling, the compressors are controlled by space temperature, so as the cooling load decreases, coil temperature and the discharge air temperature of the air rises. Dehumidification capacity falls off rapidly.
- Peak dehumidification load from occupants and ventilation air was 10-13 tons.
- Equipment dehumidification capacity was 3.8 tons.
- An Omnisense datalogging system was installed with the following points:
    - Theater air near floor
    - Theater air high
    - Outdoor air
    - Mixed air (return air/outdoor air) into the air handler coi
    - Discharge air from the air handler

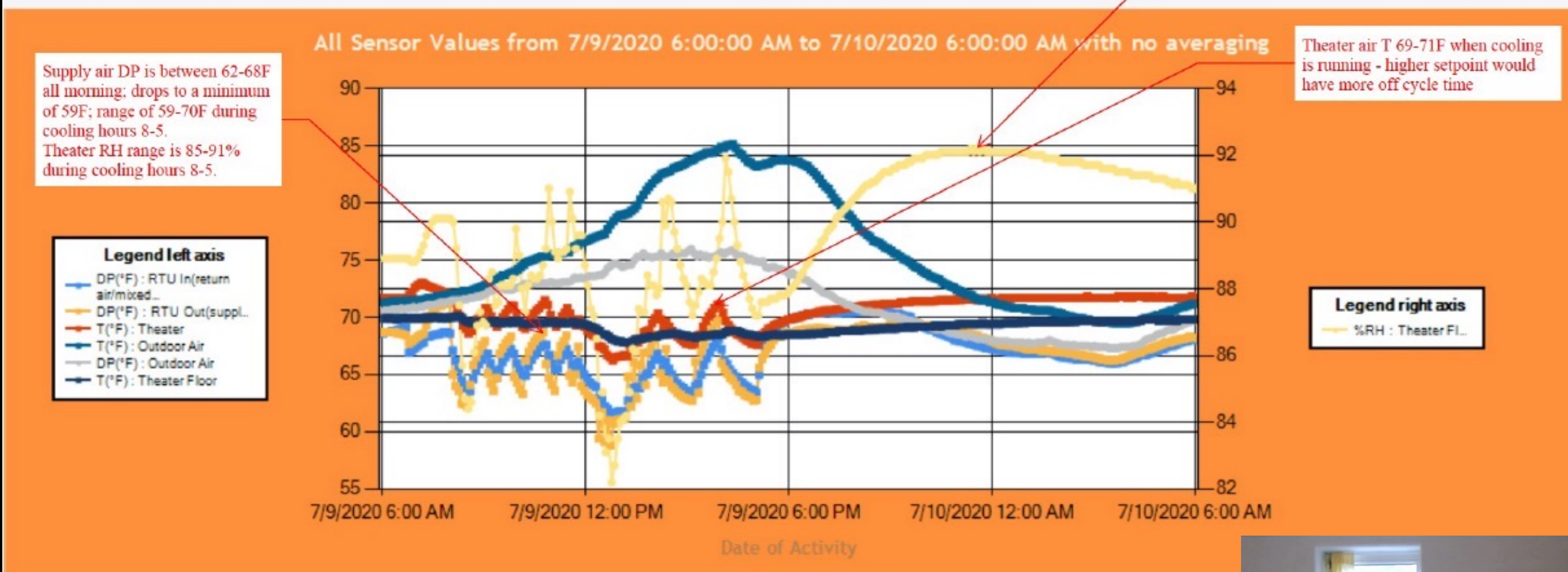
The Case of the Moldy Theater

Last Hour · Last Day · Last Week · Last Month · Last 3 Months · Last 6 Months · Last Year · All Readings

Averaging: raw data, no avg **Start Date:** 7/9/2020 6 : 00 **End Date:** 7/10/2020 6 : 00

Show values · Enable Recenter · Enable Tool Tips · Refresh

Theater floor RH 82-92% even when cooling is running



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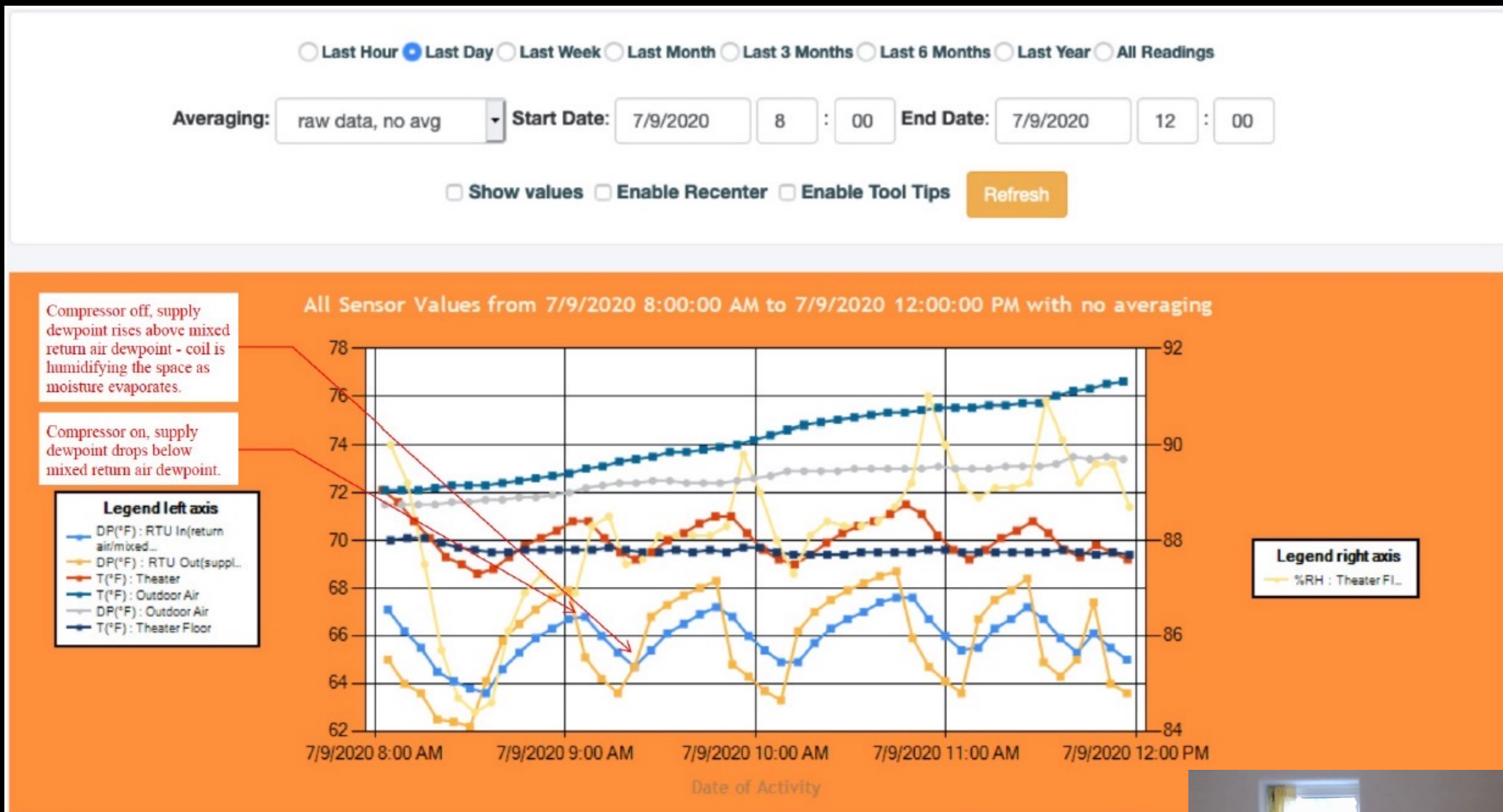
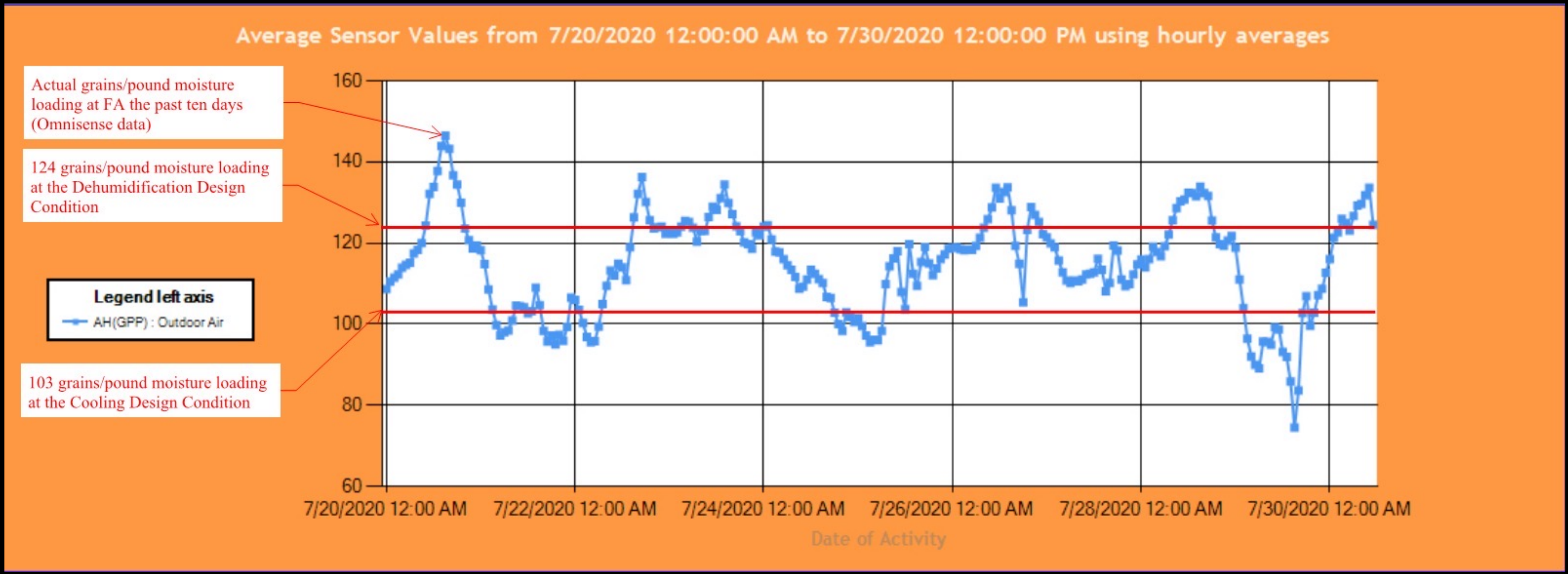
min	61.30	58.80	66.20	69.50	67.30	
max	70.60	71.20	73.00	85.10	76.00	
diff	9.30	12.40	6.80	15.60	8.70	

The Case of the Moldy Theater



	DP(°F) : RTU In(return air/mixed air):1	DP(°F) : RTU Out(supply air):2	T(°F) : Theater	T(°F) : Outdoor Air	DP(°F) : Outdoor Air	T(°
min	63.60	62.20	68.60	72.10	71.50	
max	67.60	68.70	72.10	76.60	73.50	
diff	4.00	6.50	3.50	4.50	2.00	

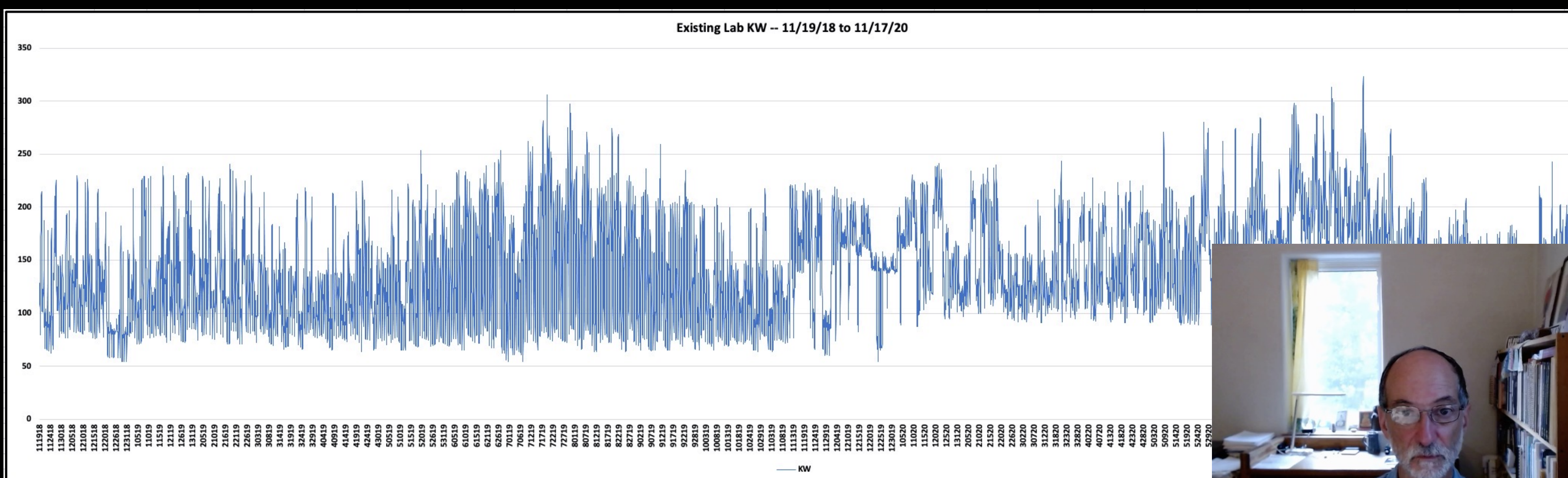
The Case of the Moldy Theater



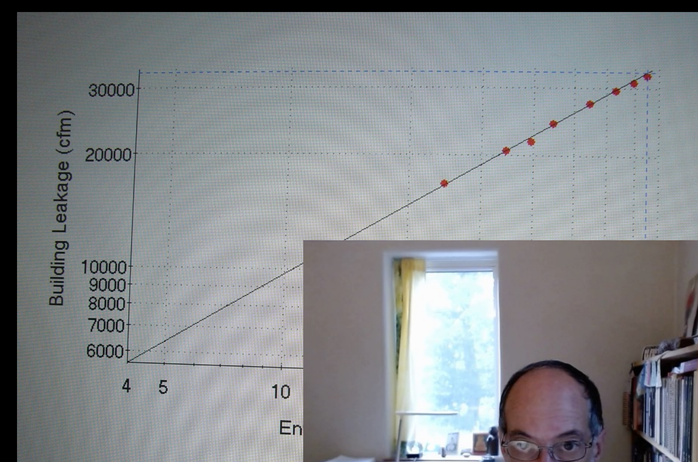
Design for Dehumidification moisture load of outdoor air is 20% higher than the Cooling Design moisture load. Peak moisture load observed was 19% higher than Design for Dehumidification load, and 44% higher than Cooling Design load.

The Case of the (Imaginary) Internal Gains

- Existing 22,000 sf lab building with planned 30,000 sf addition
- HVAC engineer's calculated cooling load for the addition was 323 tons – which works out to *38W/sf,* much of which was modeled as lab internal gains
- 2 years' worth of 15 minute electricity data for the existing facility showed a peak draw of 323 kW, or *15W/sf* – this includes chiller energy and exhaust fan energy (two large users that don't contribute to internal gains)
- Careful examination of the electricity data outside of the cooling season led to the engineer accepting that internal gains likely were between 5 and 7 W/sf
- The revised cooling load was 72 tons



The Case of the High Average Energy Use



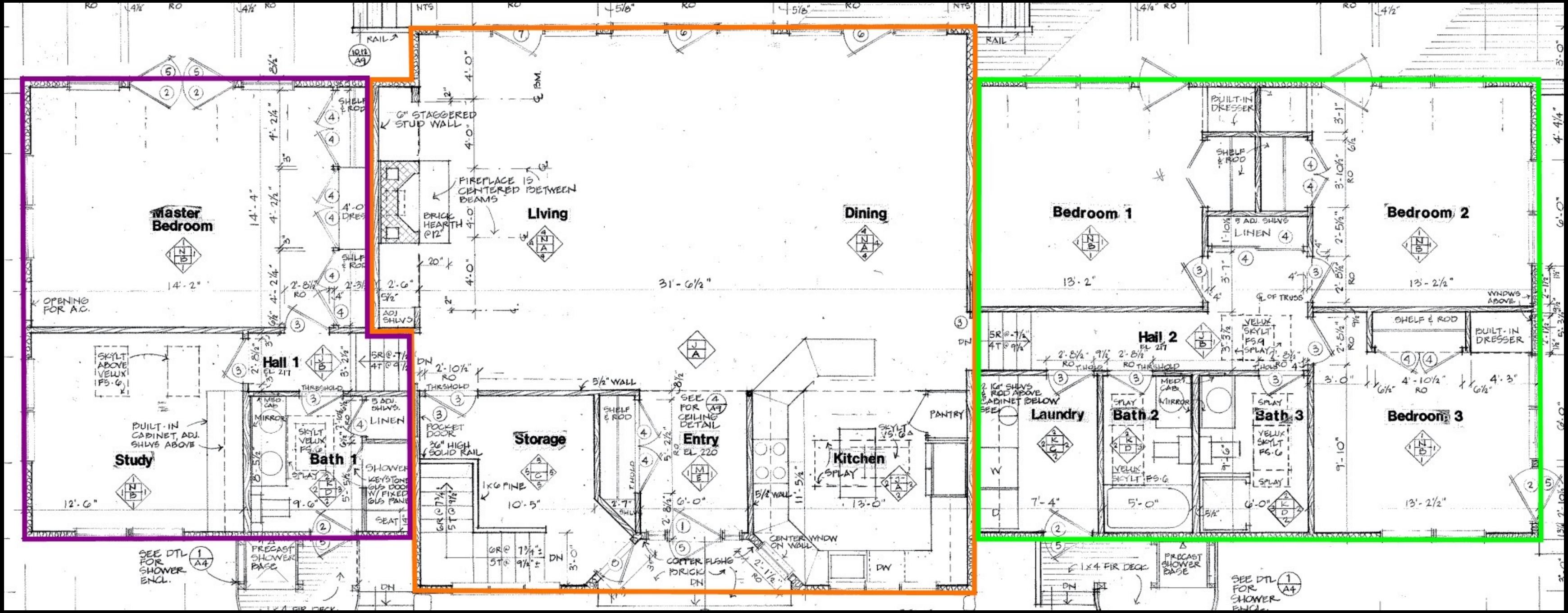
- 226,500 sf university building
- Excellent peak load performance
- Annual energy performance less stellar

The Case of the High Average Energy Use

- Peak electrical use was 1.75 W/sf
    - Lighting 0.55 W/sf
    - Plug loads 0.28 W/sf
    - Other 0.92 W/sf (NB: 178,400 sf underground parking garage, commercial kitchen)
- Average electrical load was 1.15 W/sf – 66% of peak – seemed high
- I asked MIT to look for something that was running all the time
- Kitchen hood was 6,000 CFM but variable speed based on cooking intensity
- Speed control uses an electric eye across the hood to sense opacity of exhaust (smoke), ramping up the exhaust fans as opacity increases
- Investigation showed that the hood was running at full speed 24/7
- Further investigation showed that fire suppression system piping *blocked* the electric eye, sending the false signal that exhaust opacity was always maximum
- MIT Director of Engineering estimated energy use impact as annually

The Case of the Hot Basement

- 2,400 sf House, oil furnace, three zones with motorized zone dampers



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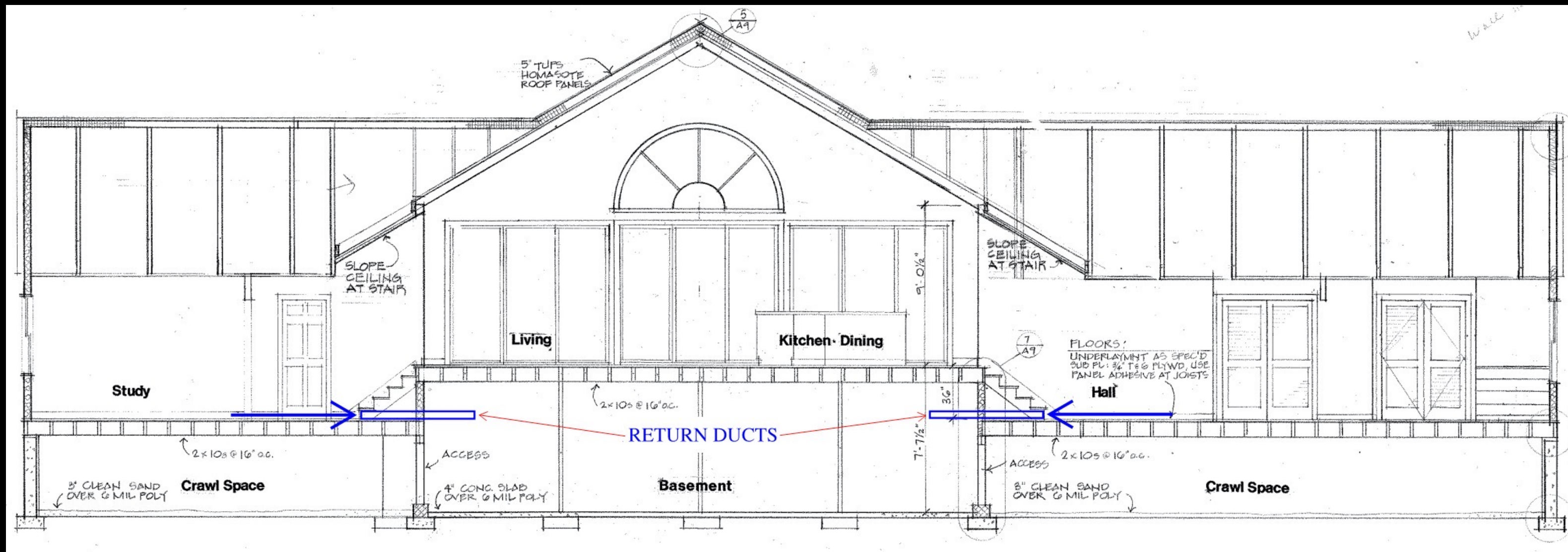
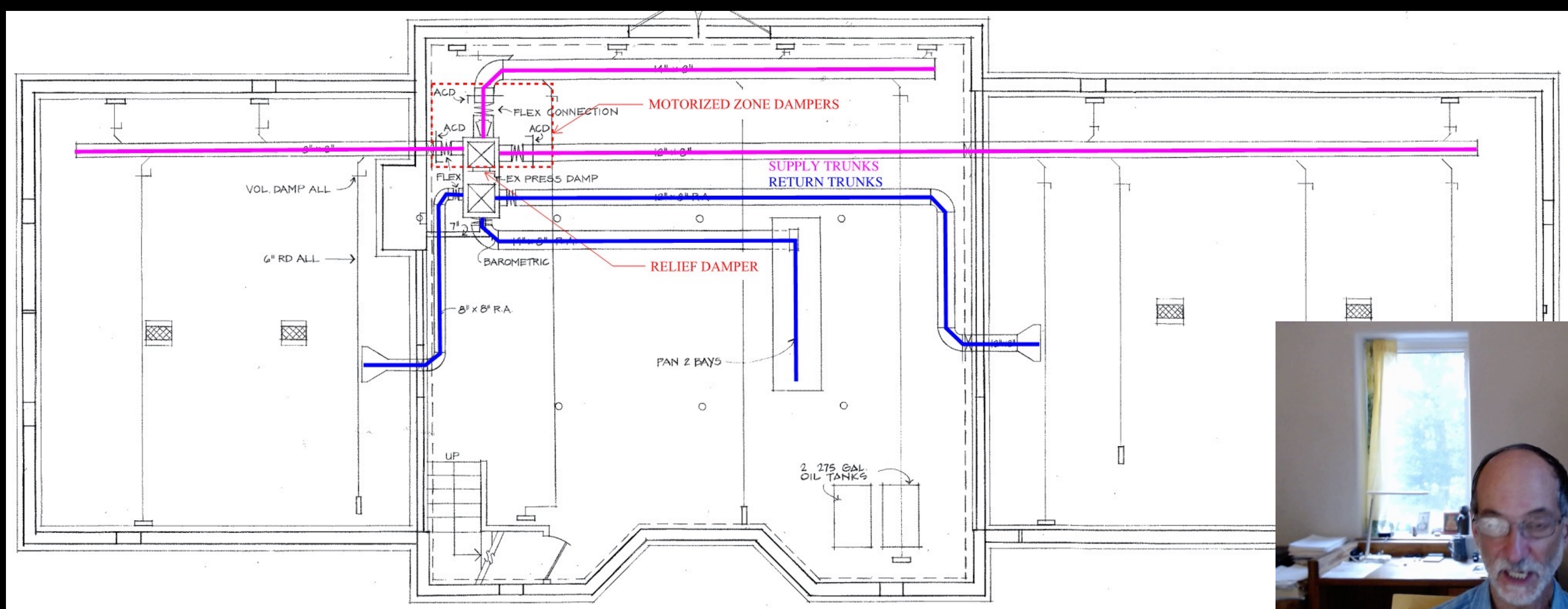
The Case of the Hot Basement





The Case of the Hot Basement

These are the ONLY returns in the house – the returns in the bedroom wing stair risers shown on the plan ARE NOT THERE

The Case of the Hot Basement

MOTORIZED ZONE DAMPER (1 OF 3)

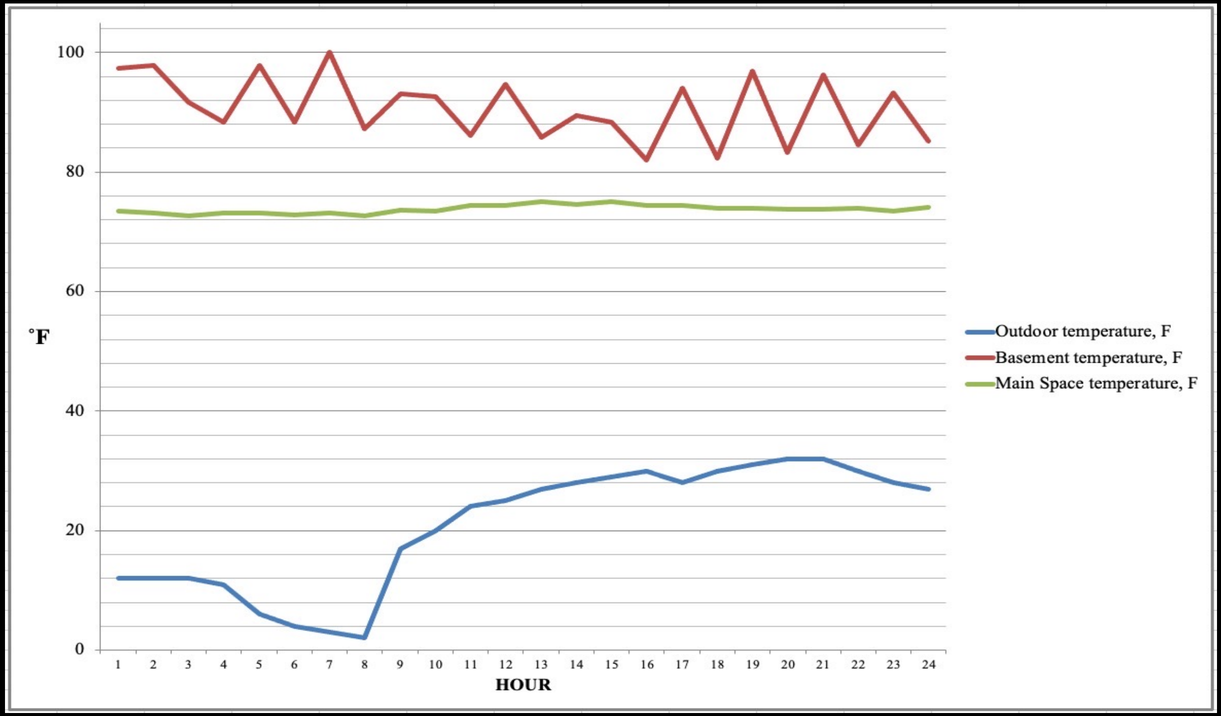
R

The gravity relief damper opens when zone dampers are close
furnace has a constant flow fan and the air must go somewher

The Case of the Hot Basement

Individual T/RH loggers in the main living space zone and outdoors, and a multi-channel logger with temperature sensors in each crawl space and the basement, as well as a current transformer on the oil burner to track burner run time

The Case of the Hot Basement



- One 24 hour period - outdoor temp drops to 2˚F
- Bedroom wing zone thermostats are *never satisfied* due to inadequate CFM, so those zone dampers are open continuously
- Basement reaches 100˚F because most of the supply air con relief damper – main living space damper is always closed
- Main living space is always warm enough – heated by the u radiant floor ☺ - slight warming due to solar gain 10 AM –