Applying a Microturbine/Desiccant CHP System to a Supermarket

ASHRAE Anaheim

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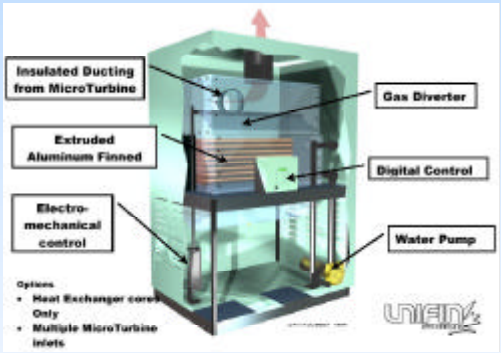
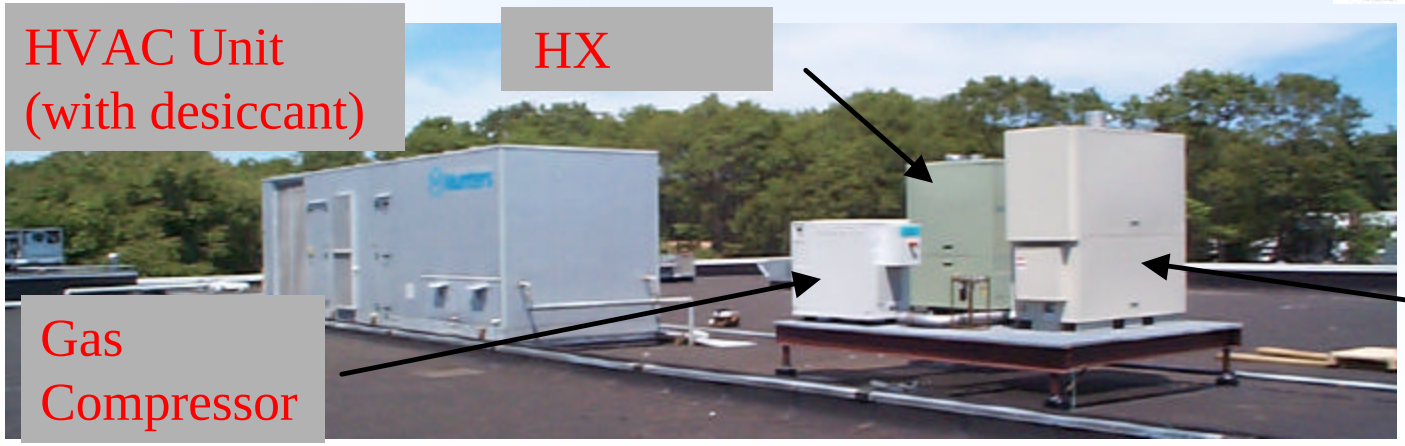
CHP in Supermarkets

- Peak is 400-600 kW for typical store
- Significant space heating loads due to refrigerated display cases
- Desiccant dehumidification is widely used in supermarkets
  - more than 1,000 desiccant units in US stores
- Good balance between thermal and electrical loads

The CHP System

- 60 kW Microturbine
- Nat. Gas Compressor (scroll)
- Heat Exchanger
- Hot Water Coils Installed in HVAC Unit

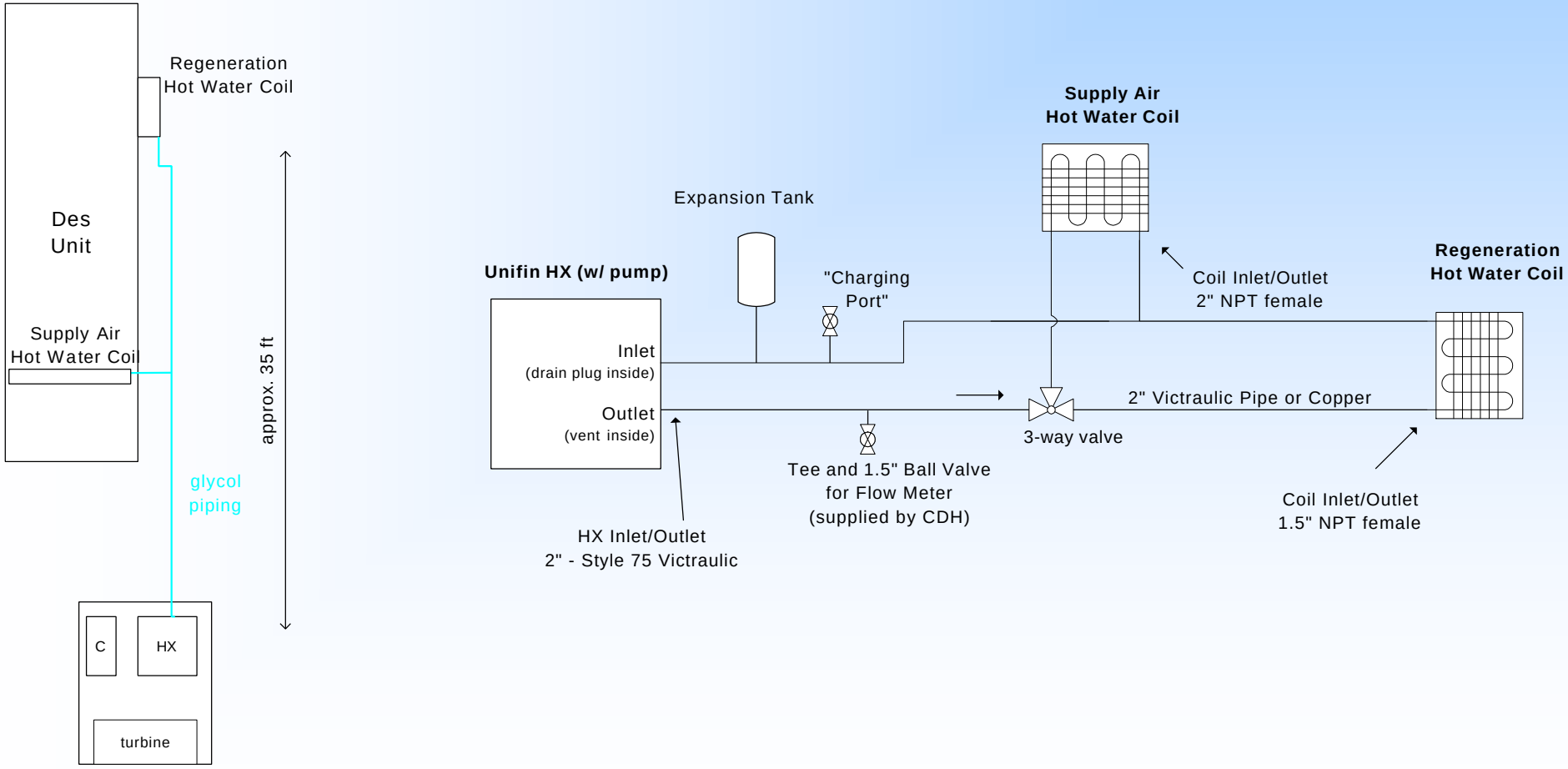




Installed CHP System

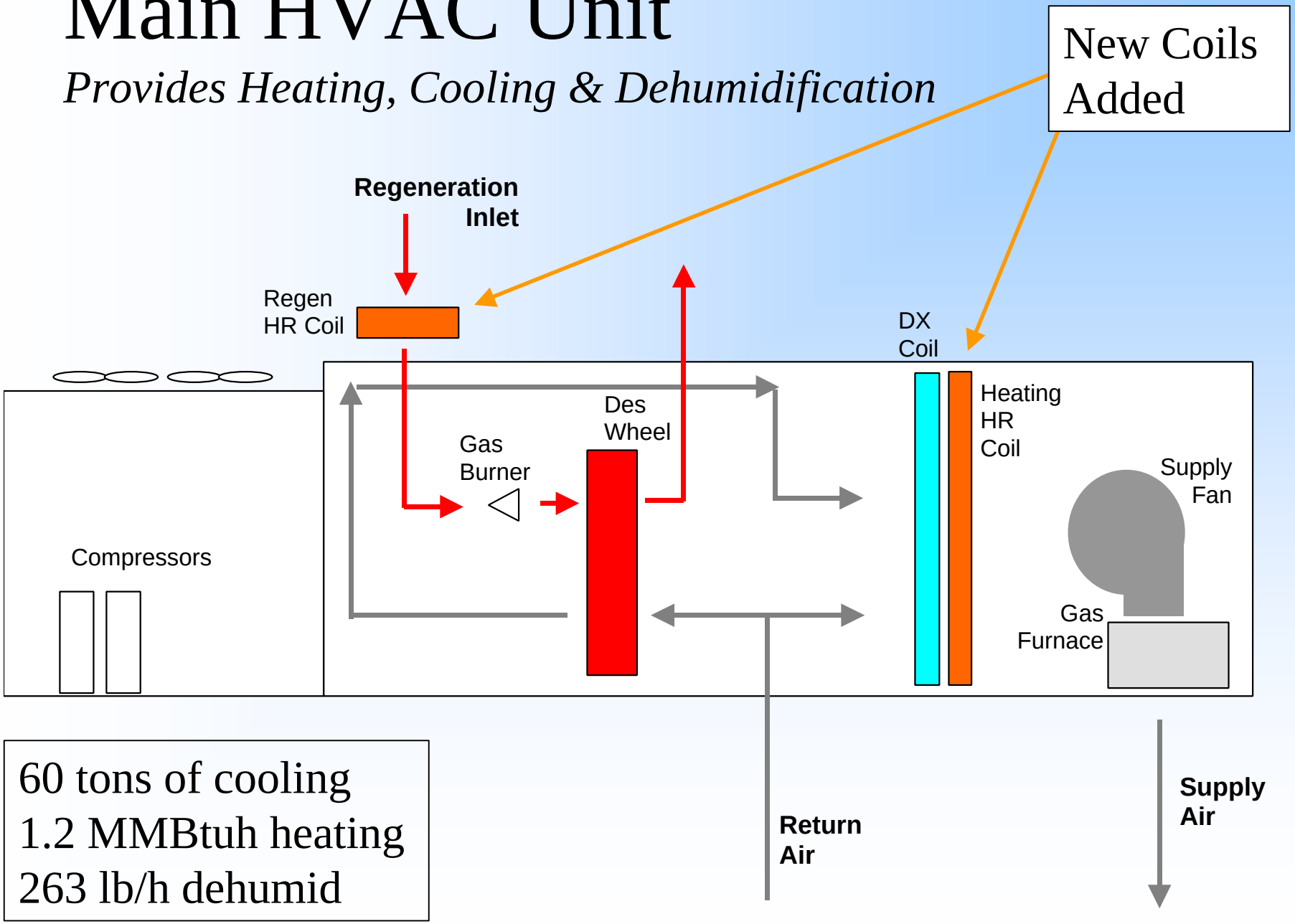
Heat Recovery System

Hot water coils installed in HVAC Unit



Main HVAC Unit

Provides Heating, Cooling & Dehumidification



60 tons of cooling
1.2 MMBtuh heating
263 lb/h dehumid

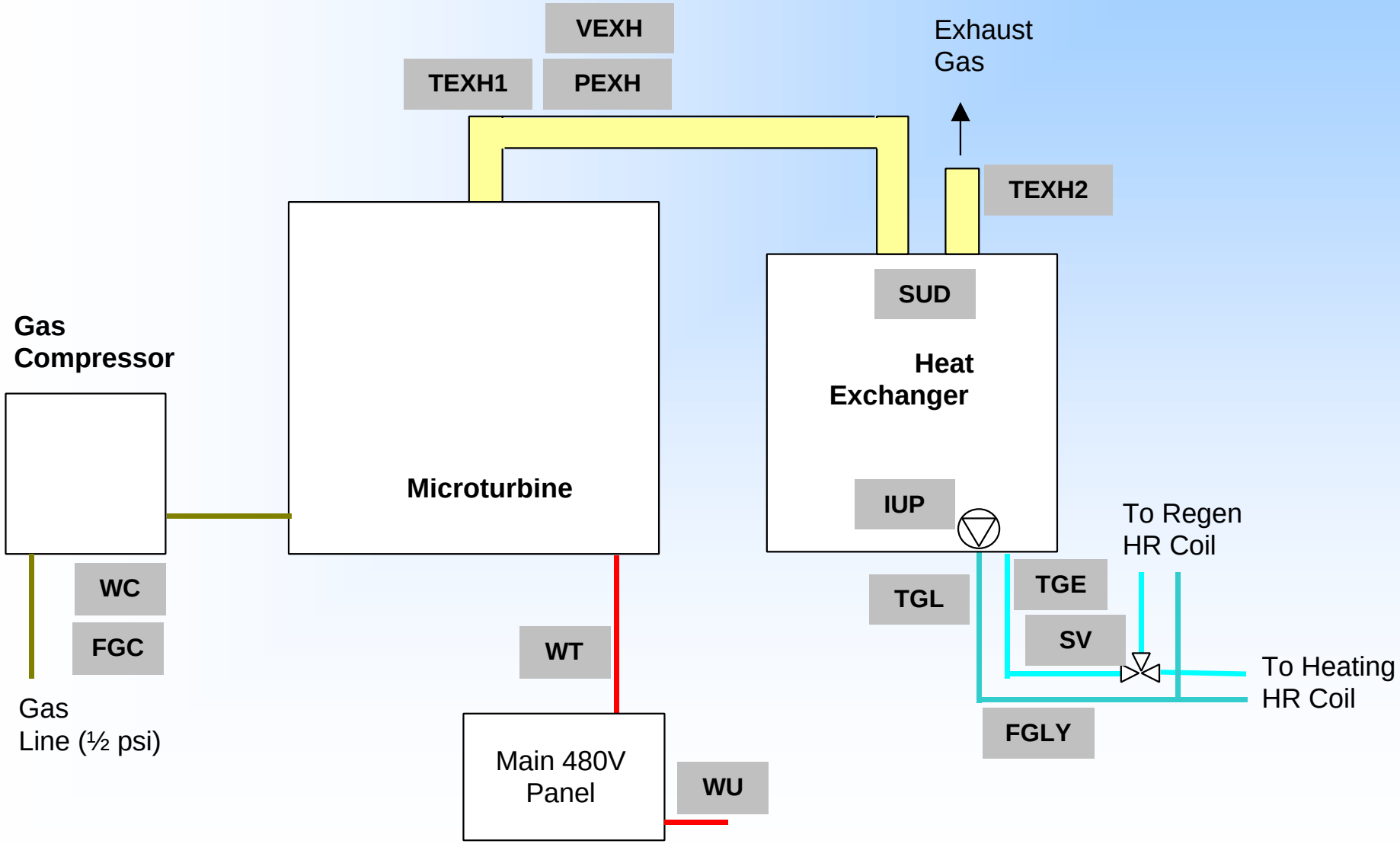
CHP System Summary

- CHP System sized for thermal loads
  - provide 60 kW of baseload power
  - grid-parallel operation only
  - may consider scheduling turbine operation for periods when heat recovery loads are low
- System can use heat recovery when available *or* Standard burner systems: fully redundant

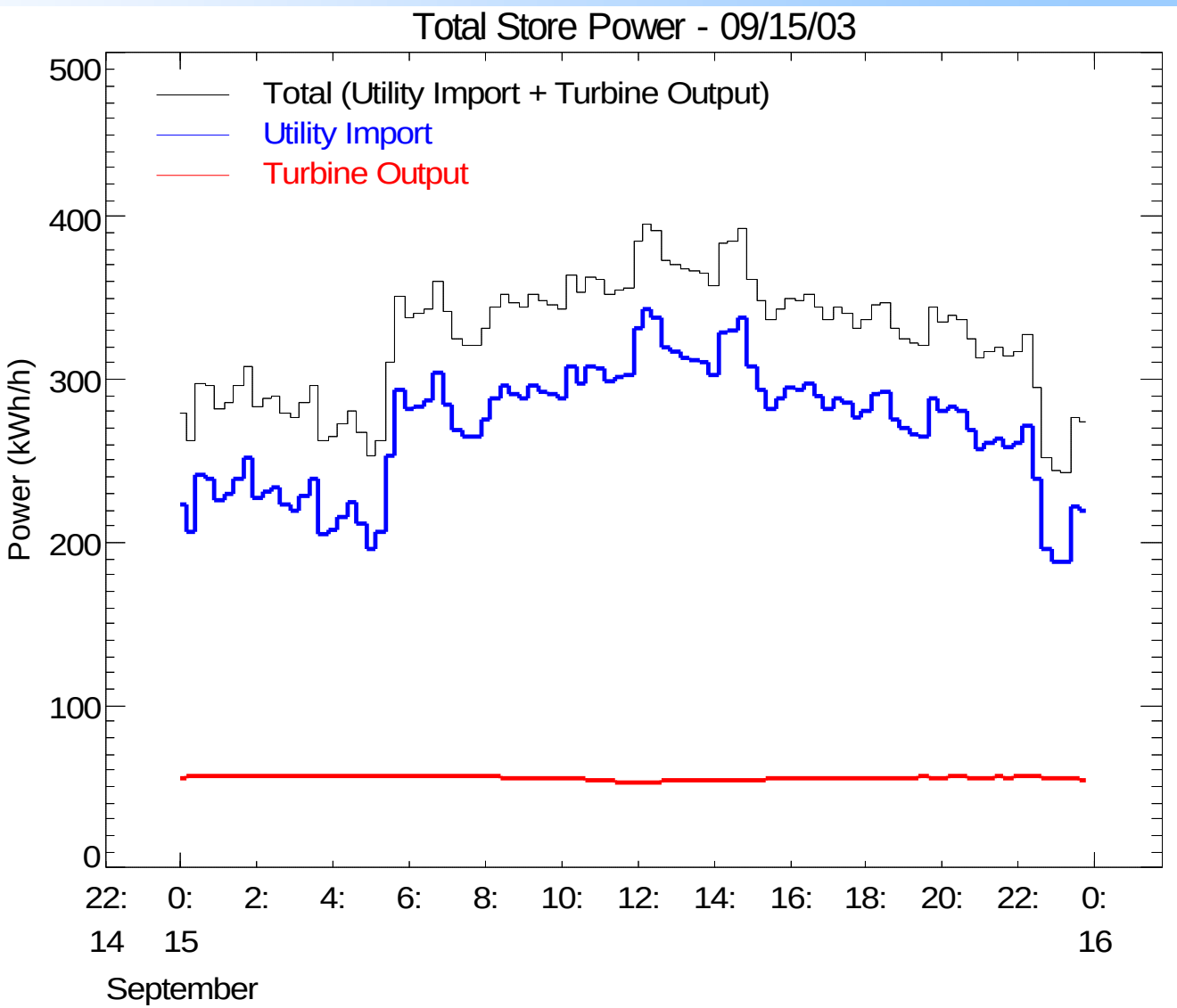
Field Monitoring

- Installed data logging equipment to quantify thermal and electric performance
  - electrical turbine output (kW, amps, volts)
  - thermal output of
  - HX (flow, ΔT)
  - turbine exhaust (T, static P, flow)
  - desiccant/HVAC unit performance (T, RH, kW)
  - 56 points total

CHP Monitoring Points



Turbine Impact on Store



Peak Total Demand: 395.5 kW @ 12:15 PM

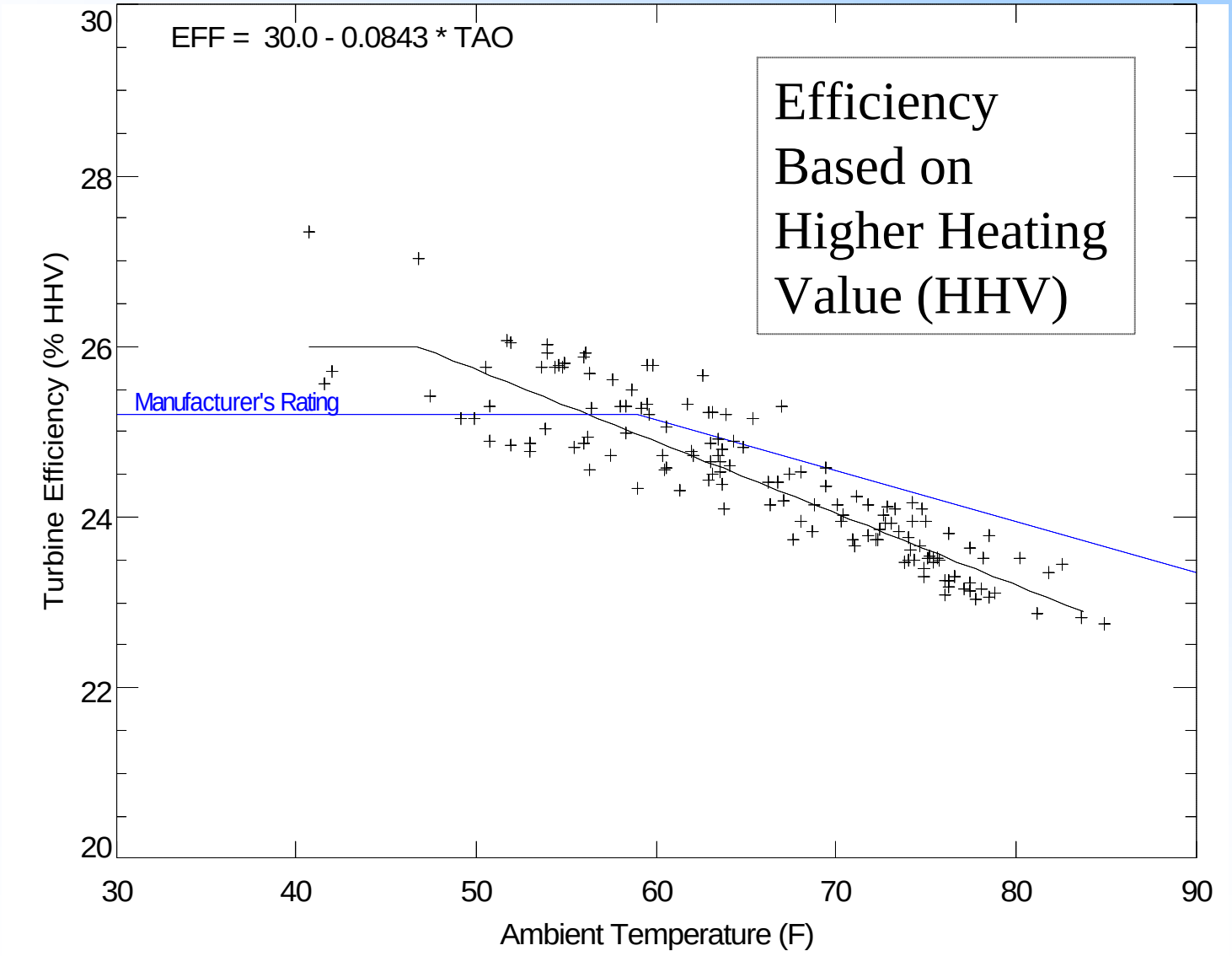
Peak Utility Import Demand: 342.5 kW @ 12:15 PM

Daily Summer-Time CHP Performance

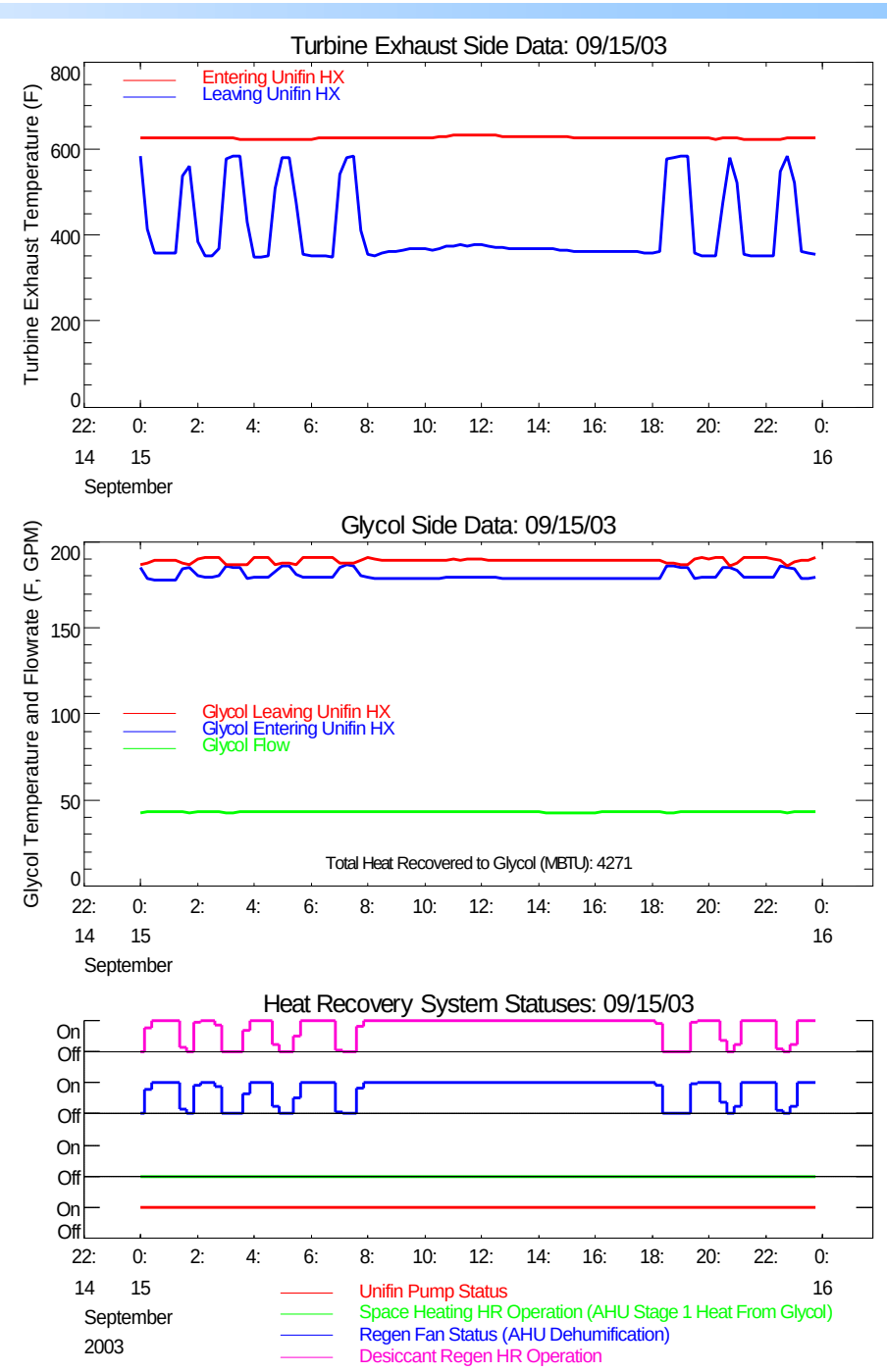
	Turbine		Parasitic Loads		Heat Recovered			[1-3-4+5+6] / [2]
Date	Power Output (kWh)	Gas Input (MBTU)	Gas Compressor (kWh)	Heat Recovery Glycol Pump (kWh)	Space Heating (MBTU)	Desiccant Regen (MBTU)	"Net" Turbine Generation Efficiency (%)	"Net" CHP Efficiency (%)
Aug 1, 2003	1,265.9	18,428	92.9	20.6	0	4,868	21.7%	47.8%
Aug 2, 2003	1,221.1	18,025	93.1	20.6	0	5,310	21.4%	50.4%
Aug 3, 2003	1,223.8	18,025	93.2	20.6	0	5,308	21.4%	50.5%
Aug 4, 2003	1,220.1	17,925	93.0	20.5	0	5,358	21.5%	51.0%
Aug 5, 2003	1,222.1	17,937	92.7	20.6	0	5,434	21.5%	51.4%
Aug 6, 2003	1,210.8	17,836	92.8	20.6	0	4,791	21.4%	47.9%
Aug 7, 2003	1,205.5	17,735	92.8	20.6	0	4,649	21.4%	47.2%
Aug 8, 2003	1,213.4	17,936	92.8	20.6	0	5,193	21.3%	49.9%
Aug 9, 2003	1,222.1	17,936	93.0	20.5	0	5,083	21.5%	49.4%
Aug 10, 2003	22.5	100	1.8	0.4	0	39		
Totals	***10,864***	***161,883***	***839***	***186***	***0***	***46,035***	***21.1%***	***49.2%***

Note: Actual natural gas HHV is used.

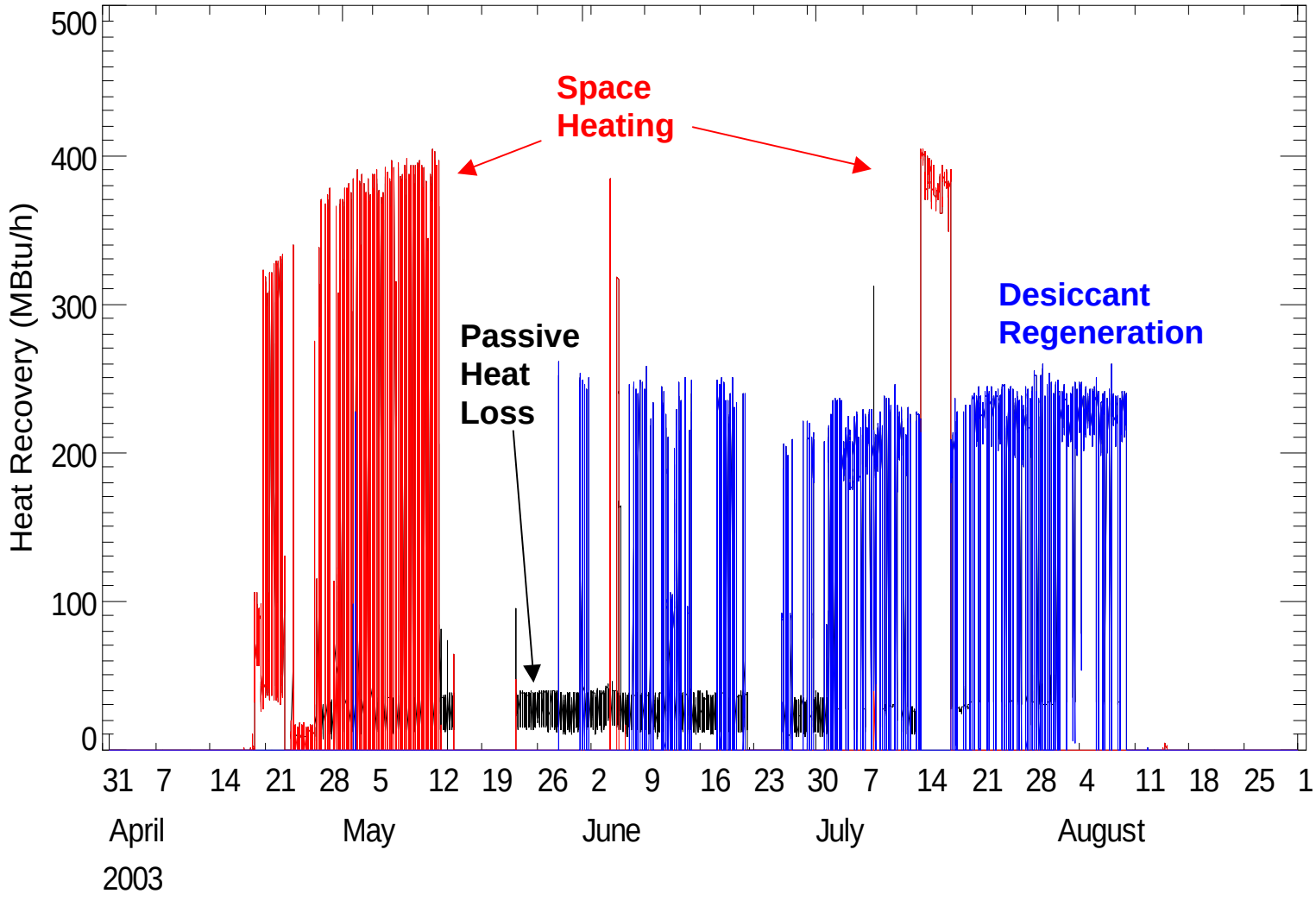
Microturbine Efficiency Trend



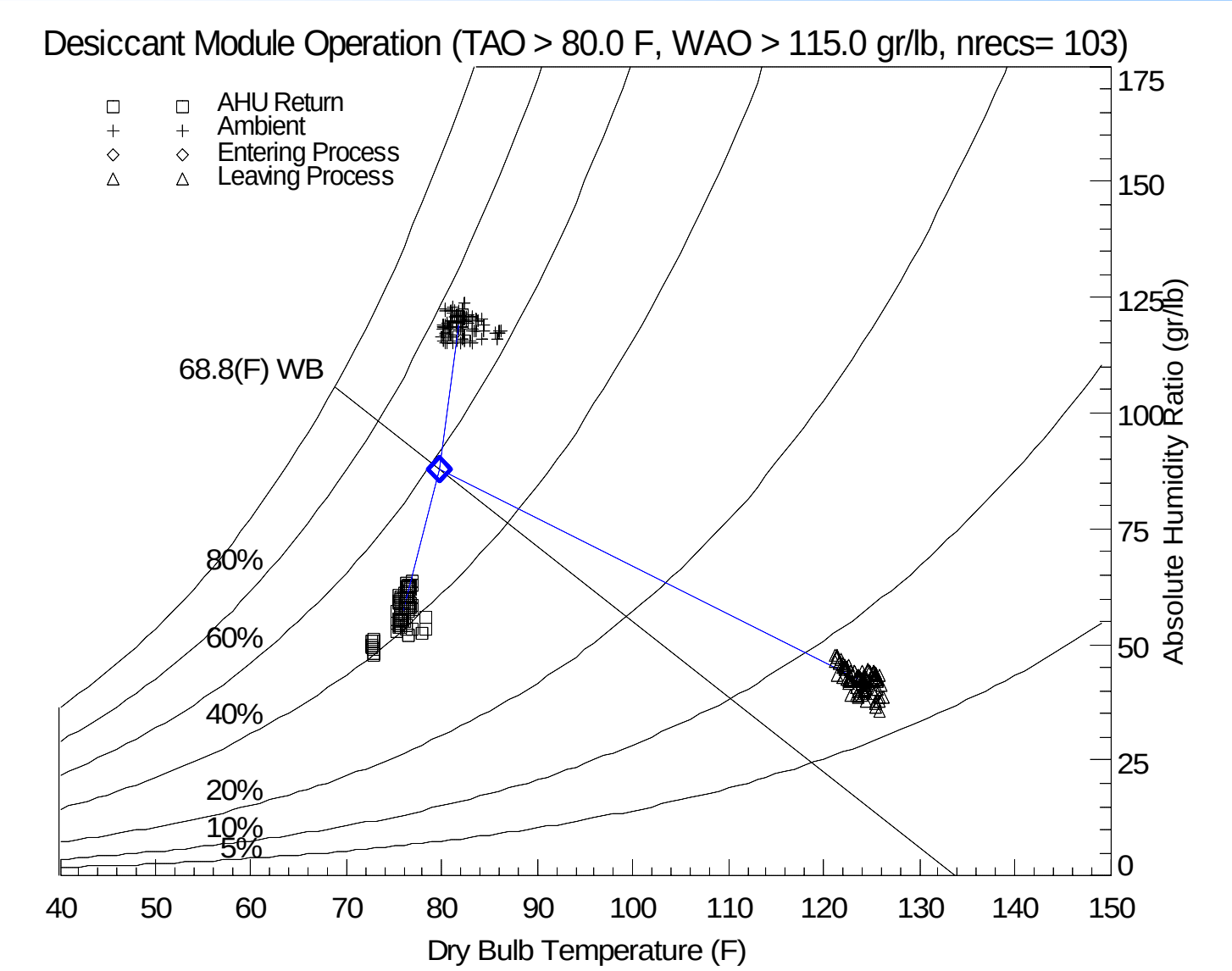
Typical Performance of Heat Recovery System



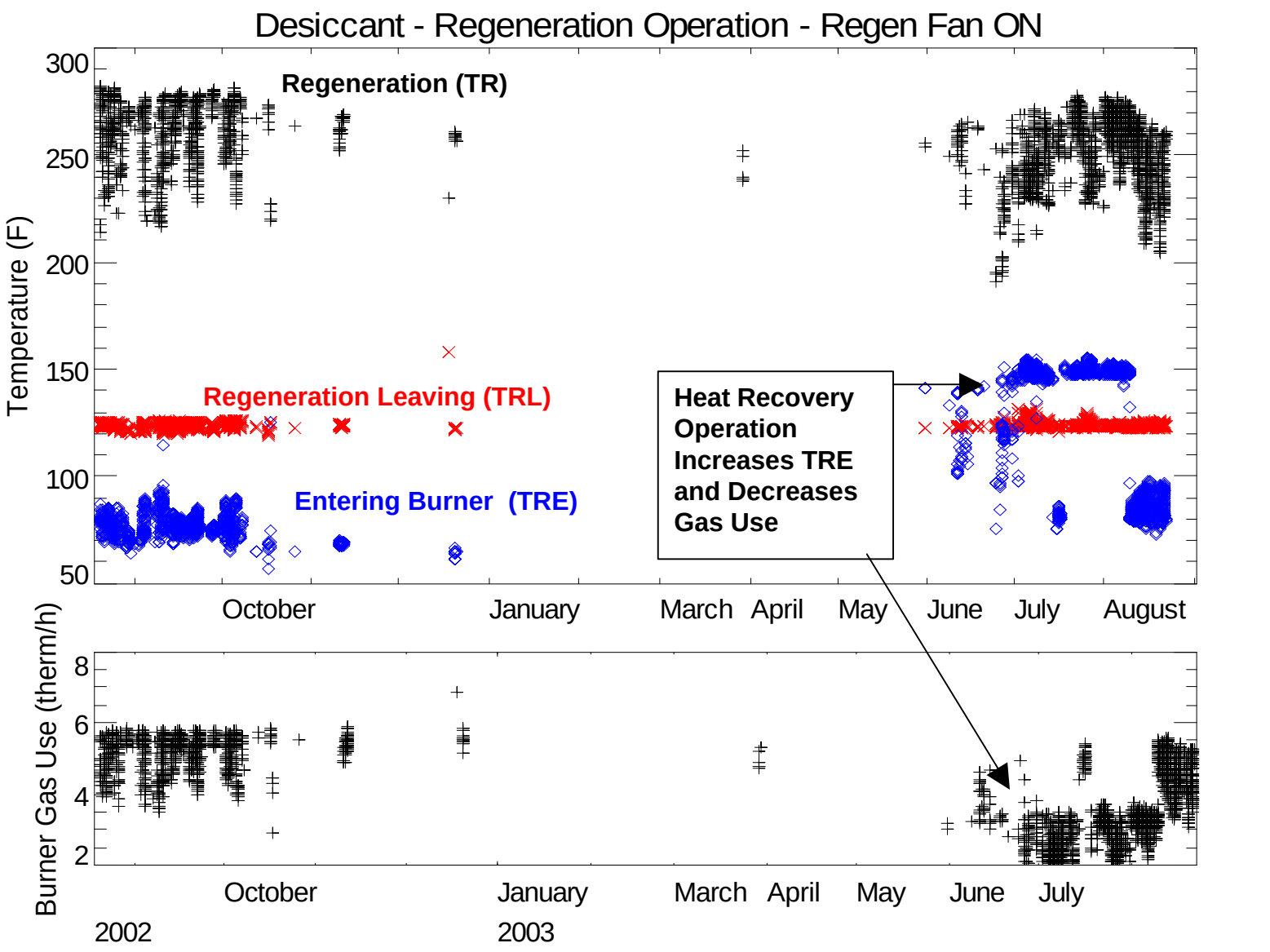
HR Rate in Different Modes



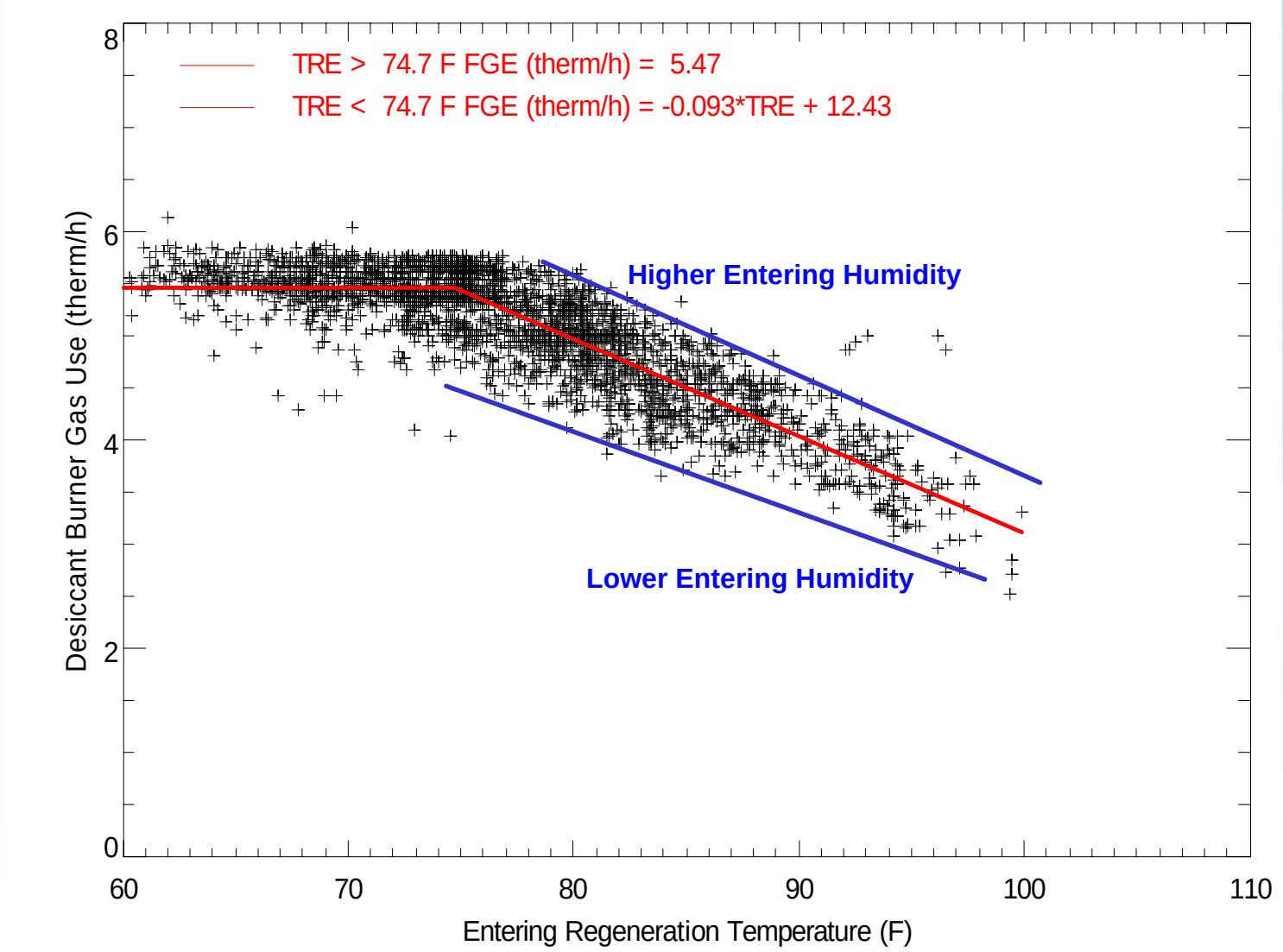
Desiccant Module Performance



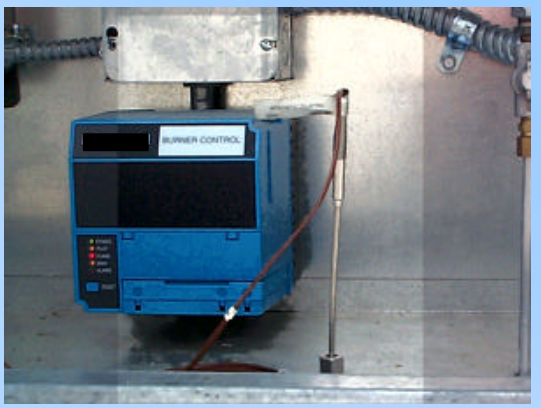
Impact of Heat Recovery

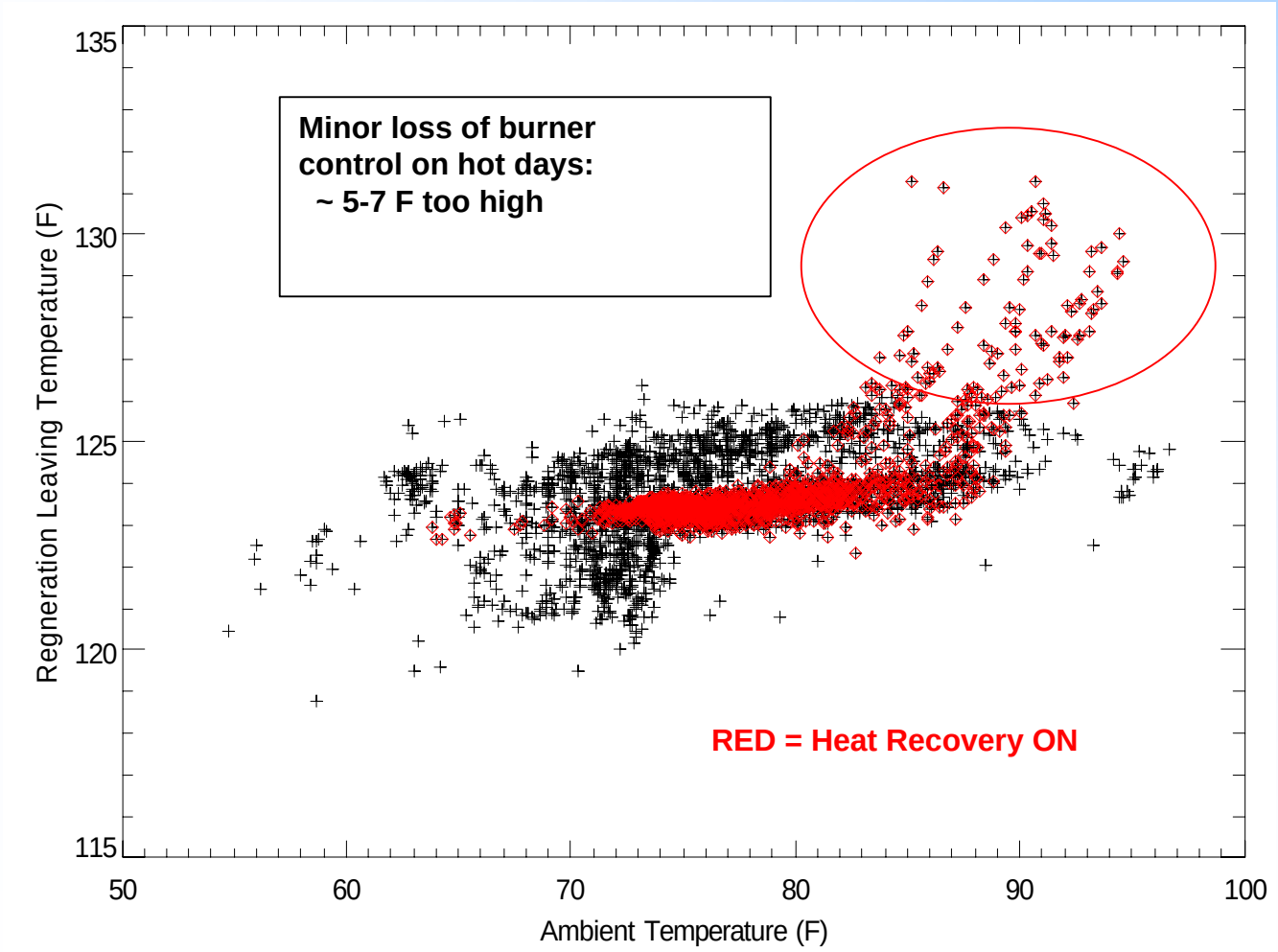


Desiccant Gas Use Varies with Ambient



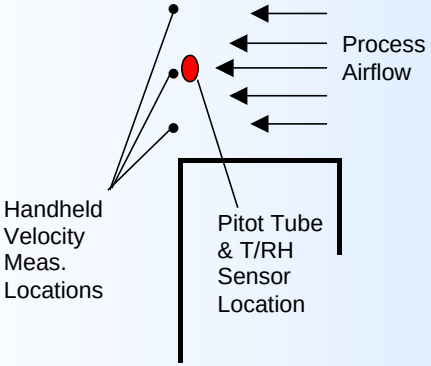
Regeneration Burner Modulation

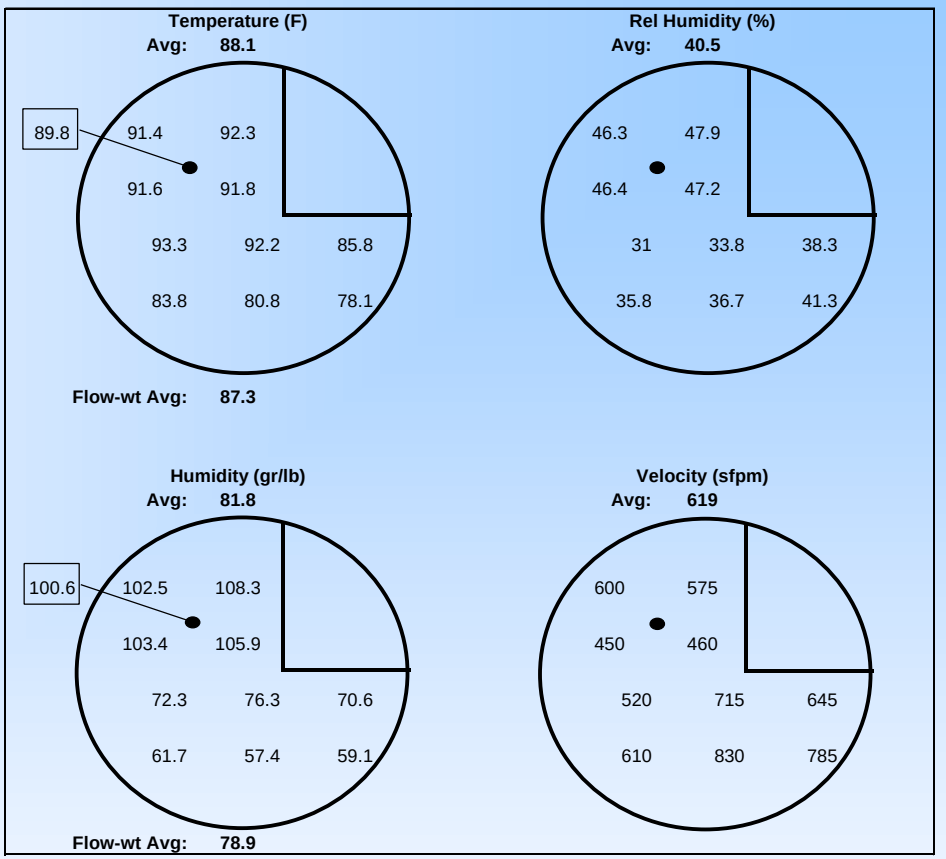




Confirmed Airflows

with various measurements

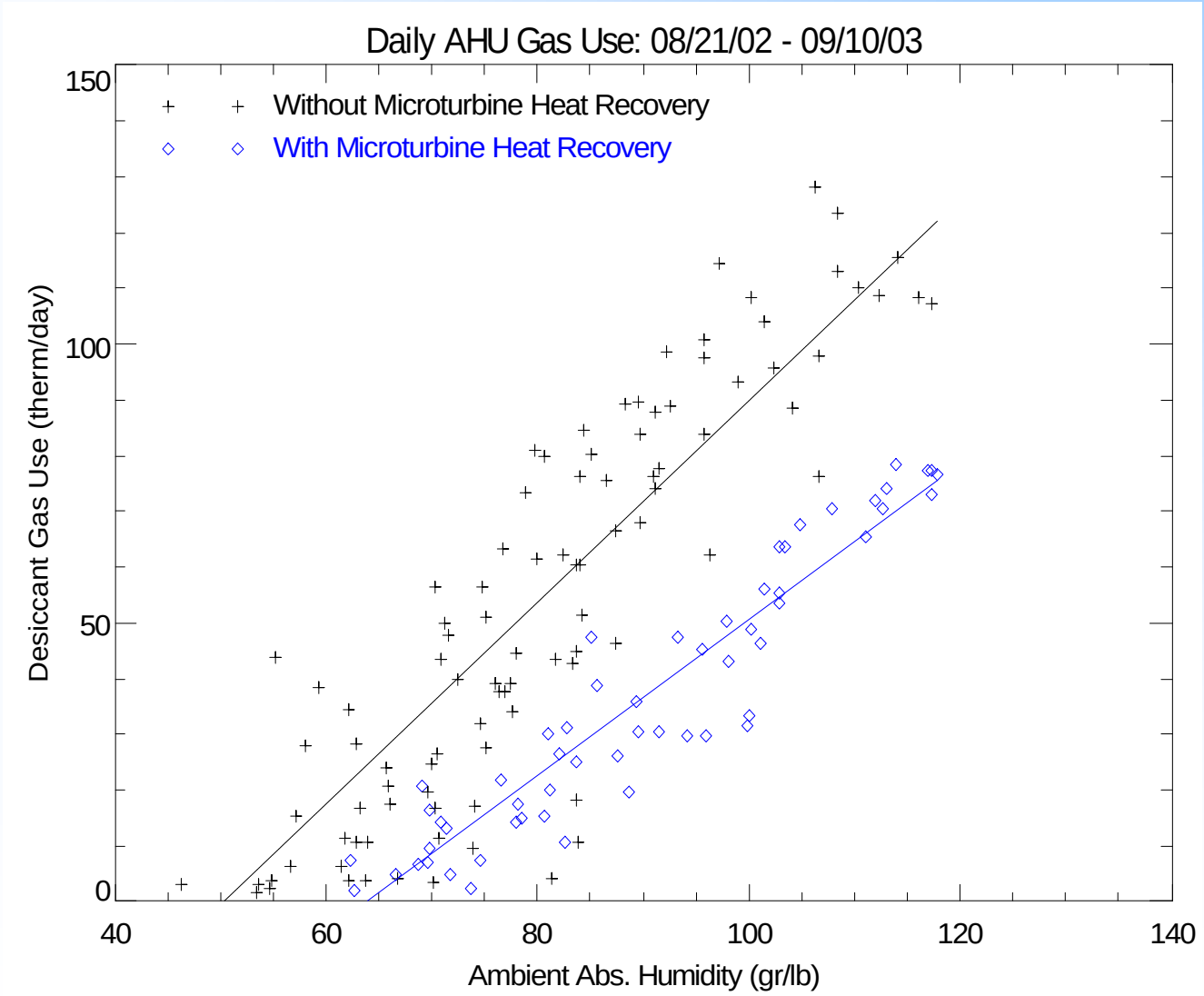




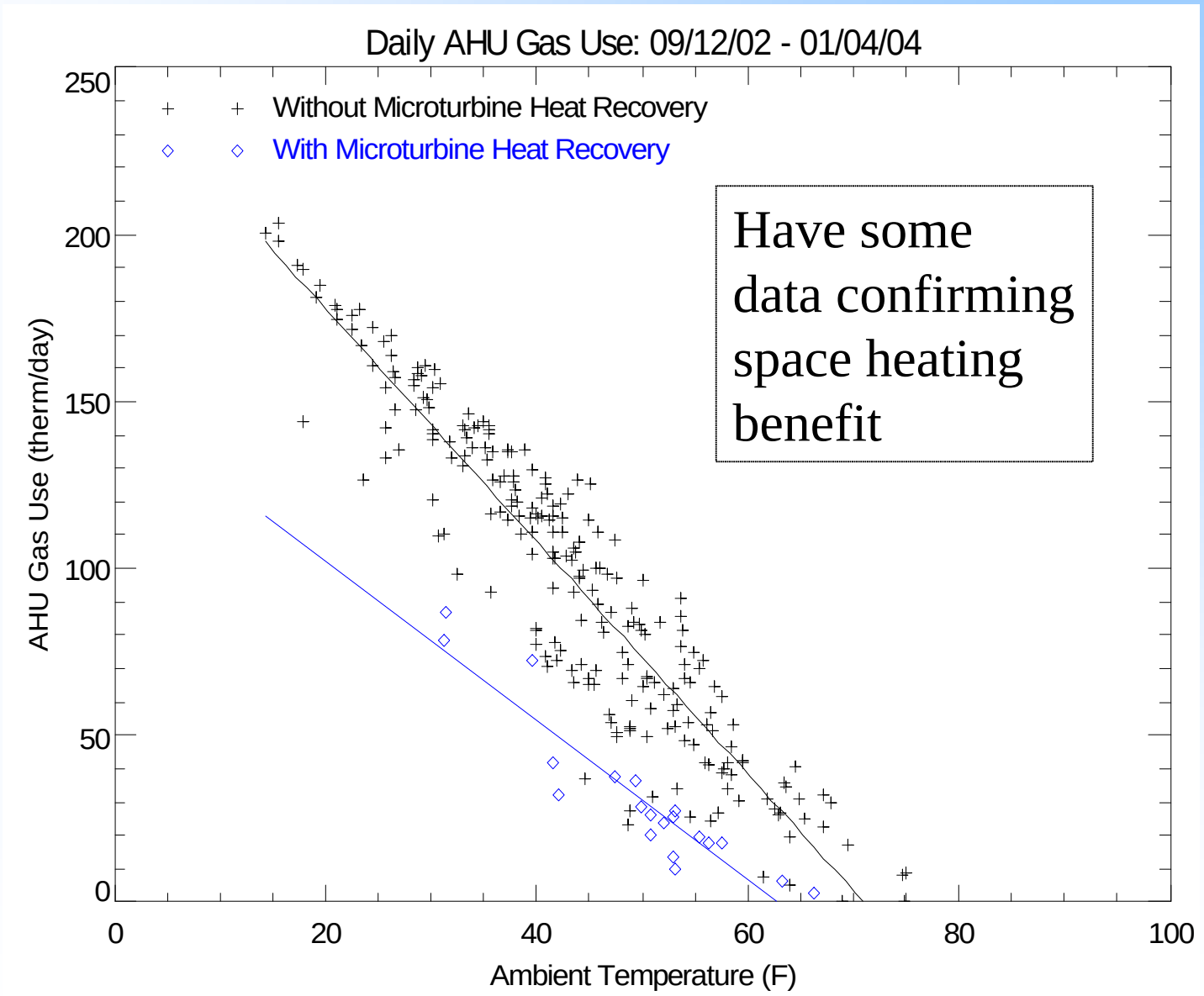
Process Airflow Measurements

Design/Nominal Process Airflow (from drawings)	9,000 scfm
Pitot Tube Measurement	8,117 scfm (-10%)
TSI Multi-Pt Velocity Traverse (Process Outlet)	
October-02	10,242 scfm (+14%)
July-03	9,380 scfm (+4%)
Semtember-03	9,447 scfm (+5%)
TSI Multi-Pt Velocity Traverse (Process Inlet)	9,628 scfm (+7%)

Impact of Heat Recovery on Desiccant Gas Use



HR Impact on Space Heating



Have some data confirming space heating benefit

Summary

- Supermarket desiccant is a good match for available heat in summer
  - HR with glycol loop meets about ½ regen gas use
  - Direct use of turbine exhaust would meet 100%
- Space heating still provides bulk of HR savings
  - At least in Northern climate
  - In Southern climate direct exhaust might be better
- Standard modulating controls on regeneration burner were adequate with HR operation