

# Retrocommissioning Investigation Study of the Sheraton Chicago Hotel & Towers Cityfront Center

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You can go anywhere you want,  
if you look serious  
and carry a clip board.

## The Project

- Saving the best for last!
- The setting: you're sitting in it!
- Owned by Tishman Hotel Corp.
- Managed by Starwood Hotels
- 1.2 million square feet
- 1,209 guestrooms
- Meeting rooms (surprise!), exhibition space (surprise!), retail, health club, offices, kitchens and dining services, and laundry (now outsourced)



## The System

- Eight CV and VAV AHUs with inlet-guide vanes, CHW valves, electric heat, and airside economizers serve public spaces
- Eighteen built-up AHUs serving support spaces, corridors, and mechanical spaces, half with CHW coils and half DX; four of these provide make up air to the corridor spaces for the guestroom exhaust
- Three 800 ton centrifugal water-cooled chillers
- Primary constant-flow chilled water loop
- Two constant-speed multi-cell cooling towers
- Constant-flow condenser water loop
- Two-pipe FCUs serve the guestrooms, with CHW coils and electric heat; three-speed fans (low, medium and high) and temperature controlled by the occupants
- No centralized BAS; all stand-alone pneumatics

## The Stakes

- It's all about the Hamiltons!
- AEC estimated that recent increases in utility rates would result in a \$1.4 million dollar increase in costs!
- This represented a 60% increase!
- Ouch!

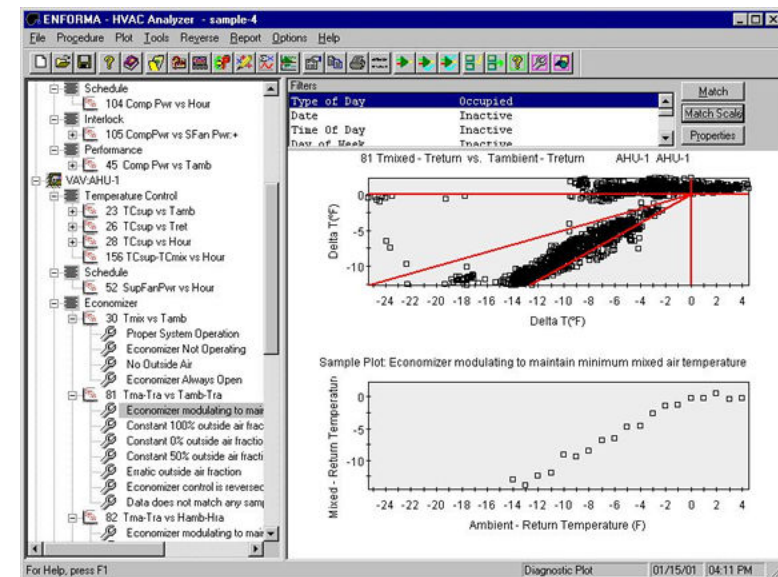


## The Process

- Retrocommissioning (RCx) *investigation*
  - applying RCx techniques, such as FPT, short-term monitoring, etc
  - targeted – *not* full blown commissioning
- Site visit, to
  - collect equipment data
  - interview facility personnel
  - install data logging equipment
  - perform FPTs

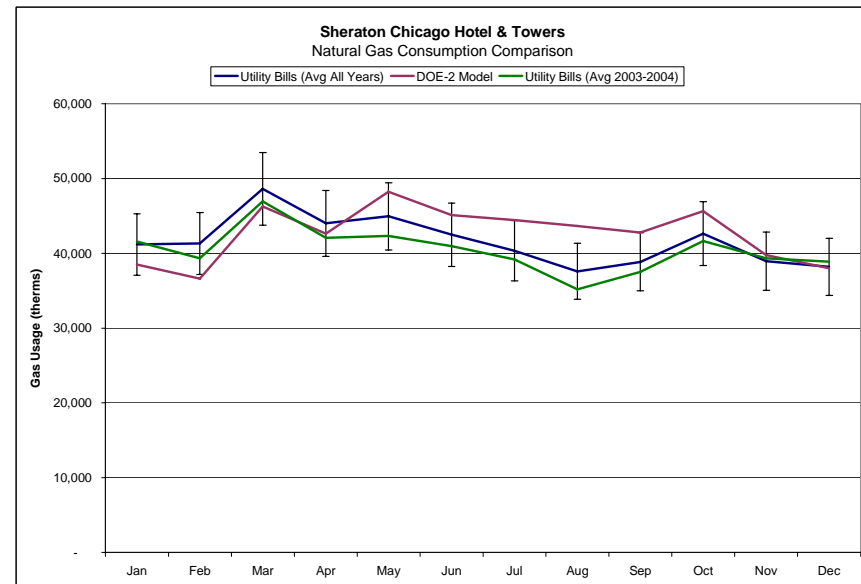
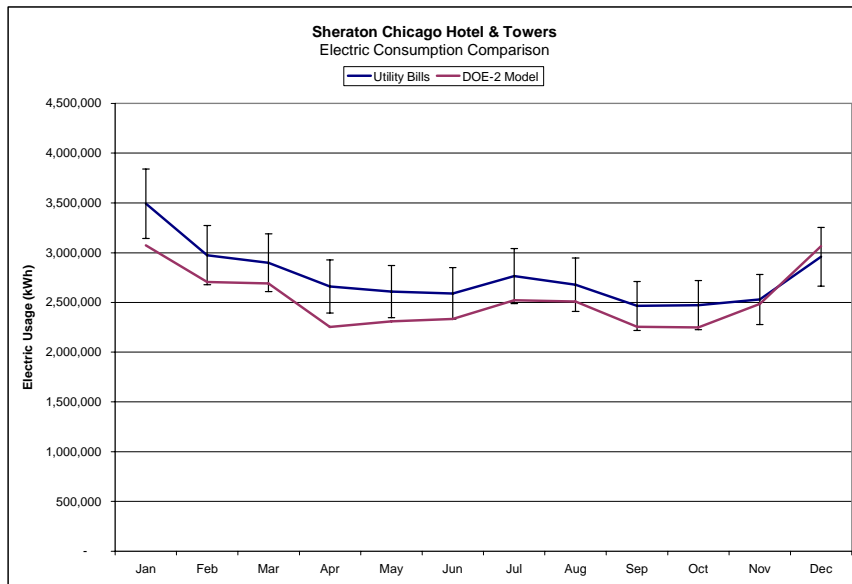
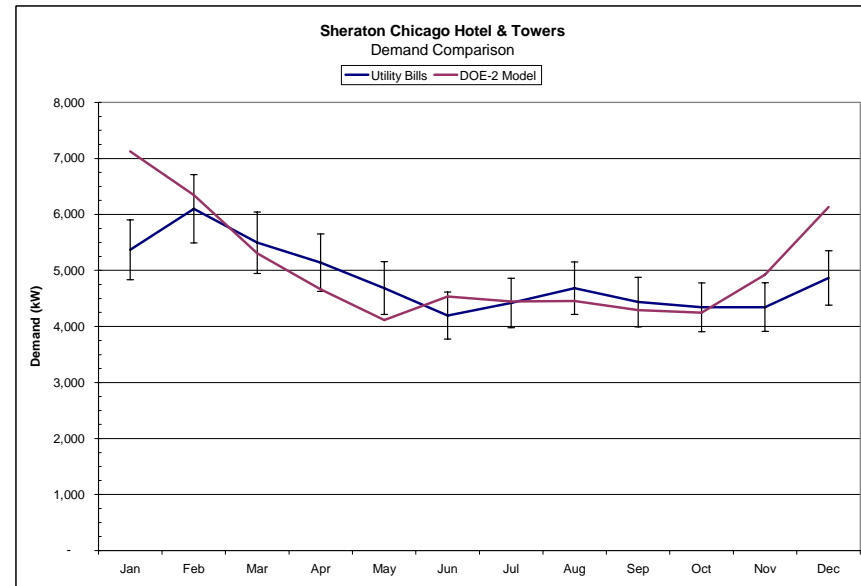
# The Process

- Developed a detailed DOE-2.2 energy model
- Analyzed short-term monitored data to
  - understand the true performance of equipment
  - look for opportunities for energy savings and improved performance
  - help bound the assumptions used in savings calculations
- Model was used to analyze economic potential of ECMs
- Packages of measures run to account for interactive effects



# Calibration

- Calibrated the model both to
  - historical utility bills
  - short-term monitored data



## The Stakes, Again



Year	Electric Usage Charge (\$/kWh)	Gas Usage Charge (\$/therm)	Total Electric Costs	Total Gas Costs	Total Energy Costs
2003	\$ 0.0603	\$ 0.5747	\$ 1,995,816	\$ 281,620	\$ 2,277,436
2004	\$ 0.0623	\$ 0.8241	\$ 2,037,906	\$ 391,312	\$ 2,429,218
2005	\$ 0.0585	\$ 1.0746	\$ 1,962,137	\$ 560,304	\$ 2,522,441
Average	\$ 0.0604	\$ 0.8237	\$ 1,998,620	\$ 411,079	\$ 2,409,698
New Rates <sup>1</sup>	\$ 0.1056	\$ 1.2357	\$ 3,214,735	\$ 632,106	\$ 3,846,841

<sup>1</sup> The rates listed are blended rates that include fixed and demand costs

## The Meat

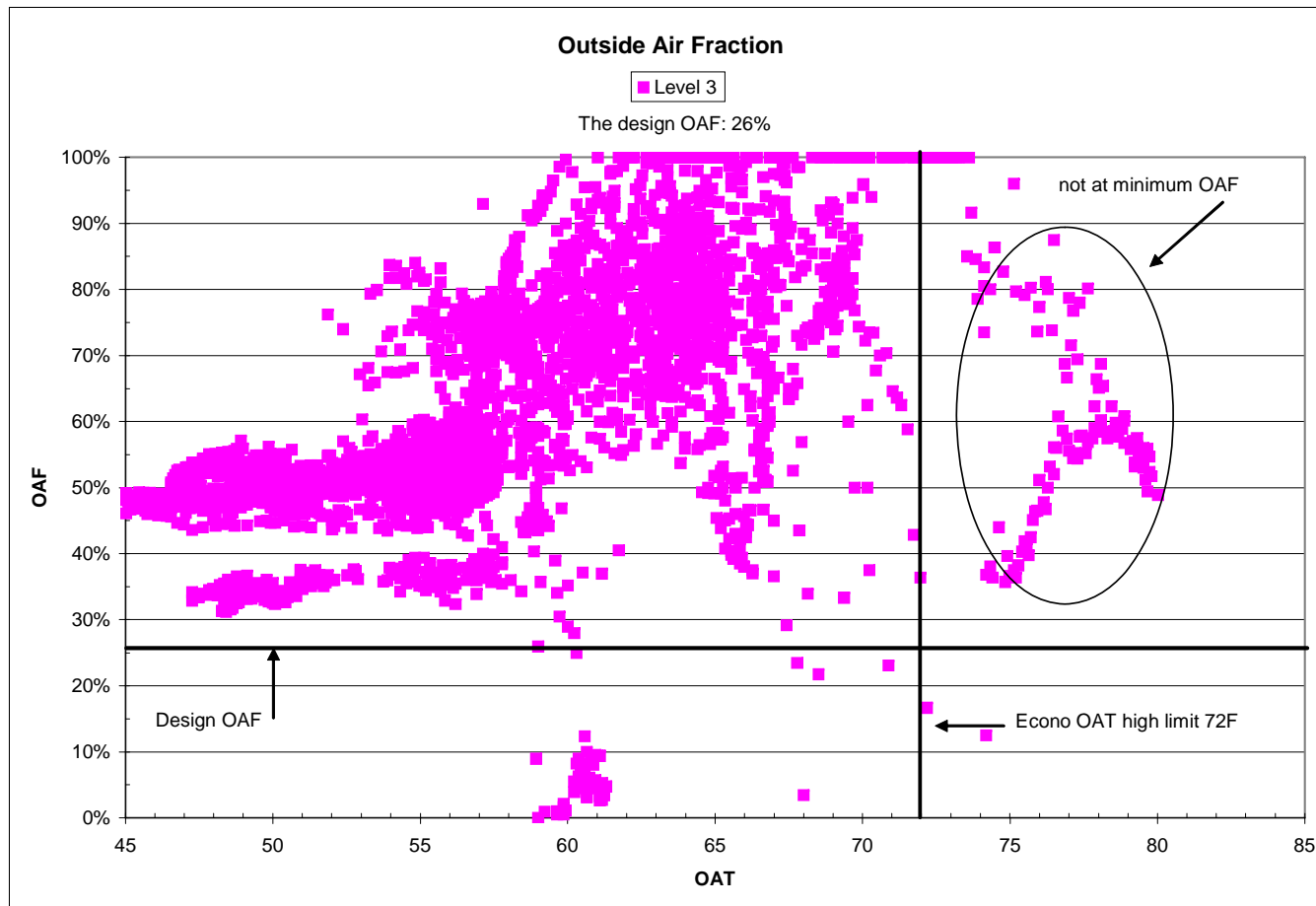
- The findings were divided into two categories
  - corrective measures deemed necessary to return the building to proper operation (RCx!)
  - energy saving measures
- Meeting subsequently held between AEC engineers, facility engineers and the building owners and managers



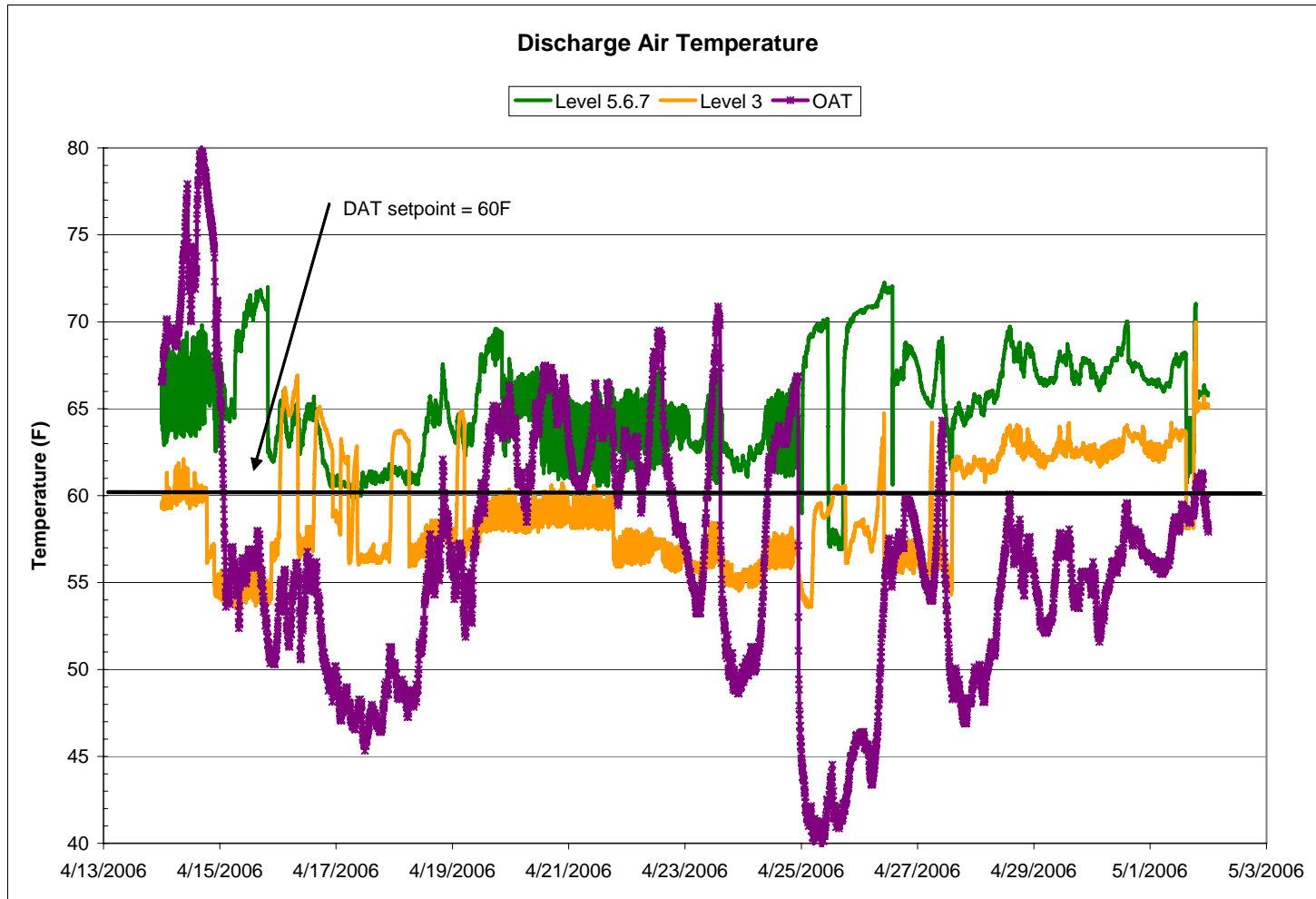
## Corrective Measures

- Correct OA fractions and economizer operation (\$98,477, 0 yrs)
  - AHUs discovered to have malfunctioning economizers
  - also identified excessive OA quantities
- Correct DAT and heating control (-\$12,882, no SPB)
  - 10°F to 15°F variations in DATs observed
  - mostly due to heating element control problems
  - identified through temperature measurements on either side of the heating elements, cooling coils and DAT

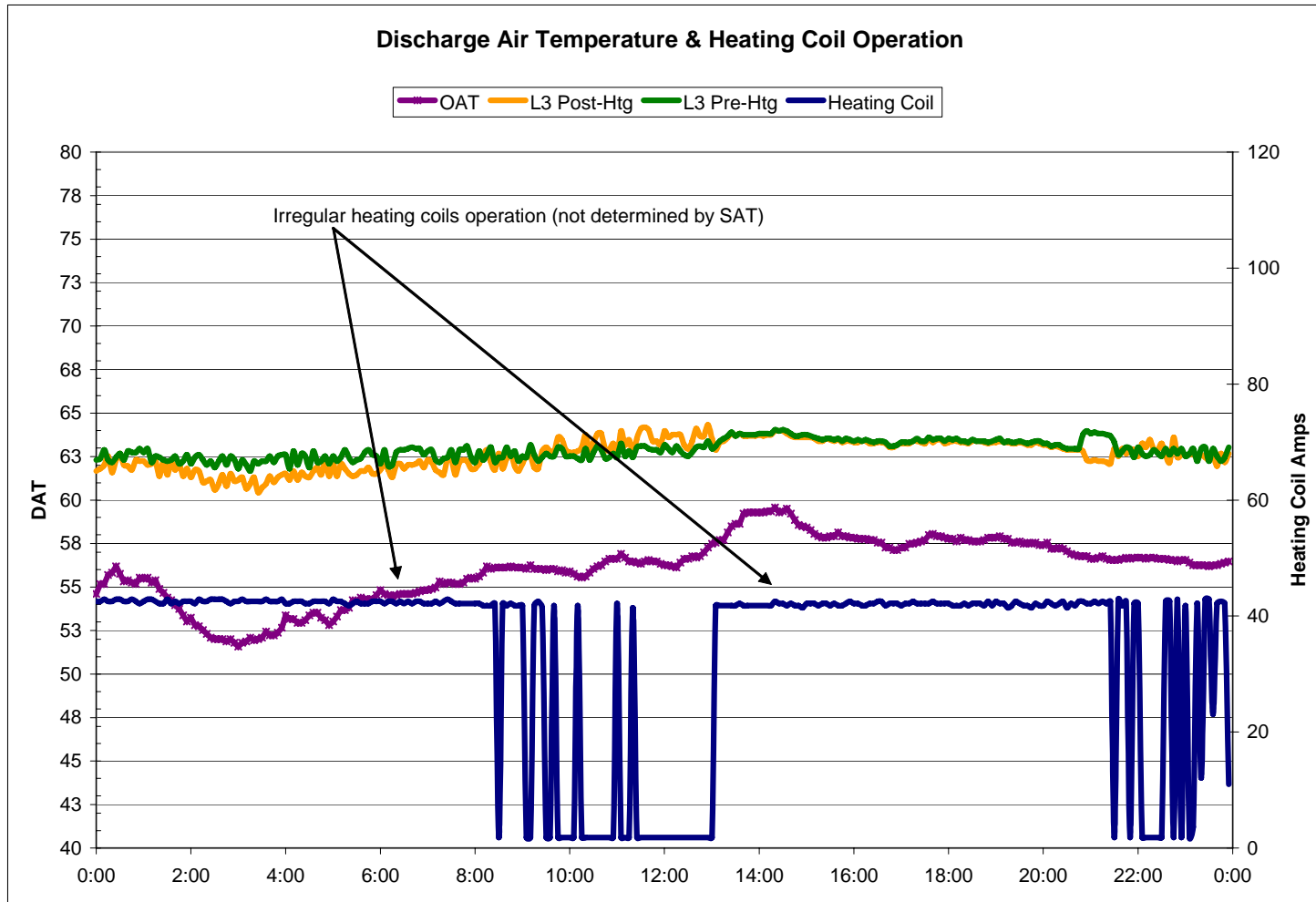
# Economizer and OA Fraction



# Discharge Air Temperature

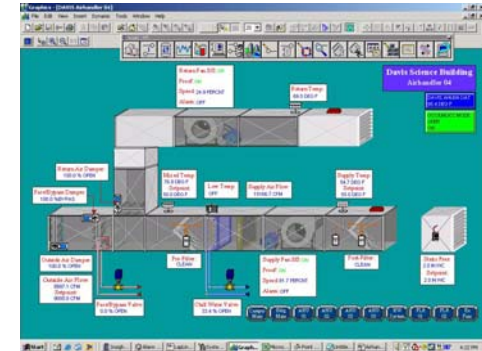


# Discharge Air Temperature

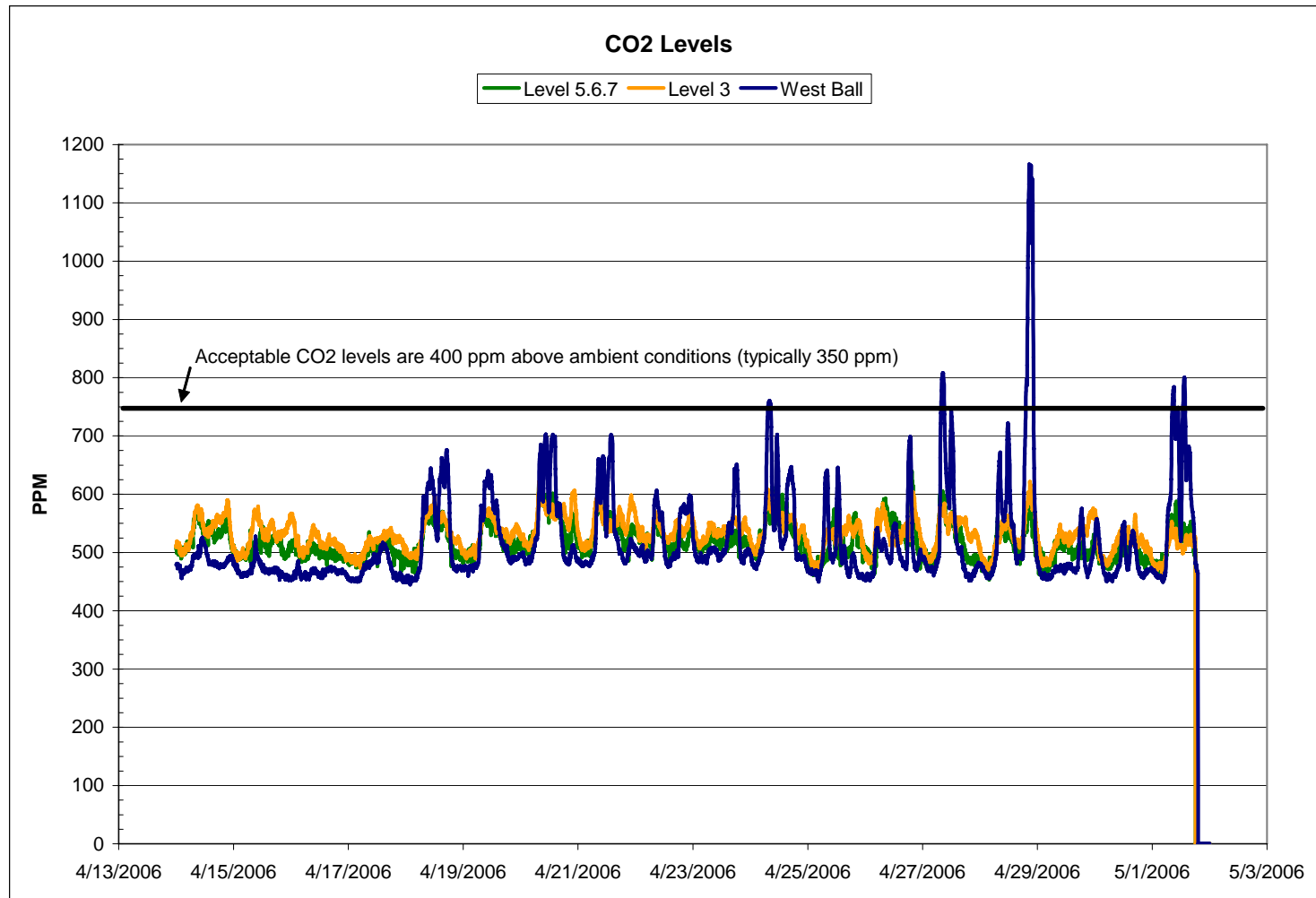


## Energy Saving Measures

- DDC! (\$702,681, 0.6 yrs)
  - unoccupied public space zone temperature set points
  - unoccupied VAV terminal box minimum airflow scheduling
  - AHU scheduling
  - unoccupied minimum outside air fraction set point
  - demand controlled ventilation
  - differential enthalpy economizer control
  - DAT reset based on average terminal box damper position
  - mixed air temperature set point reset
  - CHWST reset based on OAT; CWST reset based on wet-bulb
  - automated chiller plant enable based on OATs



# Demand Controlled Ventilation



## Energy Saving Measures

- Networked guest room HVAC controls (\$114,225, 4.9 yrs)
  - “smart” digital T-stats
  - cooperative control between an infrared occupancy sensor and a door lock sensor
  - zone set point reset +/- 5F during unoccupied periods
  - networked to new DDC system, so can reset an additional 3F to 5F when unoccupied



## Energy Saving Measures

- VFDs on the AHUs (\$113,151, 1.6 yrs)
  - fix in place the existing inlet guide vanes , and add VFDs.
  - include static pressure reset
  - considered conversion of CV AHUs to VAV, and DDC control of terminal boxes, but ultimately not included due to significant implementation cost increase, and the potential disturbance to regular hotel operations
- Replace electric resistance heating elements with steam coils (\$120,798, 1.3 yrs)
  - additional piping and valves required
  - better efficiency and control than electric heat

## Energy Saving Measures

- Replace existing 800 ton chiller with new 400 ton chiller (\$62,150, 2.7 yrs)
  - plant has excess capacity
  - allows greater flexibility regarding accurately matching cooling loads
  - greater efficiency since new and the smaller chiller would operate closer to its full load capacity at low loads
- Waterside economizing (\$40,592, 2.3 yrs)
  - install HX between CW and CHW loops; isolation valves, piping and controls
  - CHW cooled by CW loop when OA wet-bulb adequately less than CHW set point
  - allows for cooling of southern exposure rooms during lower OATs, without using the chillers

## Energy Saving Measures

- High efficiency heating DHW boilers (\$33,847, 2.7 yrs)
  - replace aging 80% boilers (five) with high efficiency (94%) condensing boilers
  - requires retrofitting the flues with a suitable material for condensing type applications
- Replace 75% pool boiler with 95% efficient new boiler (\$1,365, 2.9 yrs)



## Energy Saving Measures

- Exhaust fan and damper control in guestrooms (\$3,727, 9.4 yrs)
  - exhaust dampers in guest bathrooms interlocked with bathroom light, but many tested are not functioning and have failed open
  - installation of two-position actuators on the exhaust air dampers
  - commissioning of all of the guestroom exhaust dampers
  - installation of VFDs on the four EFs and the makeup air fans serving this exhaust system
- Exhaust heat recovery (\$157,925, 0.8 yrs)
  - fresh air corridor units (makeup air) and toilet exhaust fan system operate continuously
  - add run around coils between exhaust and make up air units (on two of the four units)

## Energy Saving Measures

- Retrofit T-12 lighting in the garage with T-8s  
(\$20,258, 1 yr)
- Replace incandescent lamps in the guestrooms  
with CFLs, and the T-12 vanity lamps with T-8s  
(\$58,163, 2.2 yrs)
- Retrofit lighting in the Illinois Board room  
(\$54,399, 0.2 yrs)
  - Significant reduction in cooling loads



## Measures Considered but not Selected (Yet)

- Stand-alone guestroom HVAC controls (networked option provided greater savings and better simple payback period)
- Automated guestroom lighting control (unacceptable simple payback and perceived operating problems)
- VAV retrofit of CV AHUs and DDC control of terminal boxes (first cost)
- Replacement of all existing chillers with high efficiency models (first cost)
- Conversion of the single loop chilled water loop to primary/secondary arrangement, with a variable-flow secondary loop (first cost)
- Addition of VFDs on the cooling tower fans (unacceptable simple payback)
- Lighting retrofit and controls in public spaces (unacceptable simple payback)
- Fuel cells (lack of local incentive money)
- Repairing laundry heat recovery system (laundry now outsourced)

## Results

- 16 of 21 measures selected
- Savings:
  - 12,193,336 kWh
  - 3,376 therms
  - \$1,192,517, 32% reduction
  - SPB: 1.6 years
- Measures not selected (yet) represented an additional:
  - \$935,319 in savings, 25% reduction
  - SPB: 4.7 years



If it wasn't for the  
last minute

Nothing would get  
done

## Where are we at?

- Implementation always poses a challenge
  - having the resources to secure and evaluate bids
  - having funding available to implement
  - fiscal schedule issues
  - other bureaucratic obstacles
- So despite eye-popping estimated savings and payback periods, implementation has not yet begun eight months later
- Is there an answer?

# Implementation Assistance!

- A champion for the cause
- Someone to shepherd the process entirely, and make it reality
- Typically should be the firm that conducted the RCx investigation, and ideally the commissioning agent as well
- Involves:
  - clarification of the owner's project requirements and basis for design
  - development of specifications and detailed control sequences
  - assistance with contractor selection
  - submittal review
  - construction management
  - commissioning
  - training

# Implementation Assistance!

- Unbiased consulting services
  - Ensures the needs of the owner are being faithfully served
- Third-party helps maximize energy savings and system performance



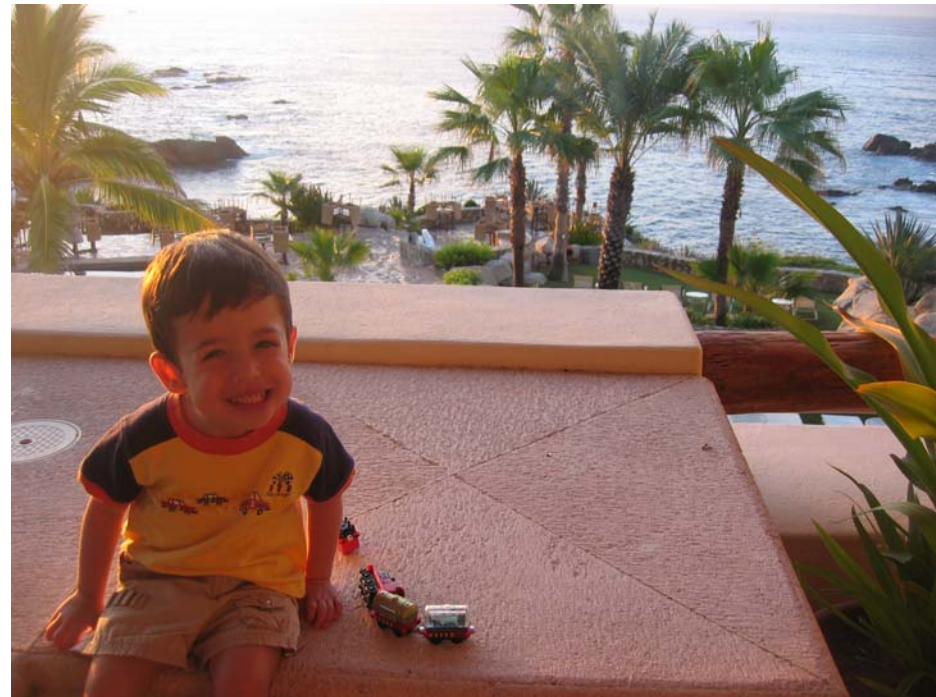


***"Now let me get this straight,  
the Arabs get the oil,  
and we have to cut off the ends of our what?"***

ROD

## Why do we do any of this?

- Gayanashagowa
  - “Seventh generation”
- In 300 years, few leaders have thought seriously in these terms
- 1973 was a wake up call for the US
- The built environment is a key element
- Queen said it best





In Conclusion,  
I agree  
with everything  
I have said