Benefits of Retrofitting Dual Evaporative Cooling for RTUs

California Commissioning Collaborative
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Presentation “Big Picture”

- Generic dual evaporative pre-cooling
- Major benefits
- System options
- DualCool background and history
- Technology details
- Integration with Commissioning
Commissioning Links

- Extended economizer cycle - requires proper economizer operation
- Optimized blower speed - requires measuring and resetting fixed-speed blower sheaves
- Economizer damper setting - must be adjusted for indirect heat exchanger pressure drop
- Optimized condenser fan settings - VFD or disabling
- Compressor disabling - to assure demand reduction
Dual Pre-Cooling Benefits

- Demand Reduction: varies with climate, refrigerant, % outdoor air, system configuration; typically 25 – 50%, or 0.25 to 0.50 kW/ton rating
- Energy Savings: varies with the above, and with blower speed adjustment; typically 400-1300 kWh/ton-yr
- Extends equipment life due to favorable compressor operating conditions
- Increases capacity and efficiency of existing equipment
- Societal: distributed generation, climate change, jobs
Dual Evaporative Pre-Cooling Features

- Direct evaporative condenser cooling
  - Media
  - Mist
  - Dangers: condenser coil damage, system maintenance
- Indirect evaporative ventilation air pre-cooling
  - Indirect cooling coil from evaporative source
  - Plate-type indirect evaporative unit (2 air paths)
  - Dangers: indirect coil freeze-up, inadequate vent air flow

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System Options 1 & 2

- DualCool: recirculating direct evaporative condenser section, sump water pumped through indirect vent coil
- “Stand-alone” Indirect system cools vent air, wet exhaust sent to condenser inlet (example: Coolerado)
System Options 3 & 4

- Cooling tower chills water that sub-cools liquid leaving condenser and, in parallel, circulates through indirect vent coil.
- Cooling tower chills water for indirect vent coil, mist system cools condenser.
DualCool Components

- Pump circulates water from sump, through ventilation air coils, to the condenser pre-cooler, and back to the sump
- Water supply/return piping
- Ventilation air pre-cooling coil

A. Condenser air pre-cooler with integral sump circulation pump, and controls (D)
B. Water supply/return piping
C. Ventilation air pre-cooling coil

As water evaporates, a refill system adds makeup water
An adjustable bleed system controls hardness minerals
Condensate from the cooling coil drains to the sump
DualCool Summary

- A patented RTU add-on system that evaporatively pre-cools the condenser air and indirectly pre-cools ventilation air.
- Initially developed in 2001 as a demand-response technology.
- Attractive RTU retrofit option in dry climates.
- Units have been installed on a wide range of RTU types and sizes.
DualCool Advantages

- Does not require a new major equipment piece on the roof
- Uses least parasitic power
- Does not invade refrigerant lines
- Uses electrical power already available at the RTU
- Lowest cost option
First Installation: Trane Rocklin Office

Monitored DualCool System Performance
(May 8th - September 4th, 2001)

RTU Total Demand (kW)

Outdoor Temperature (degrees F)

y = 0.0006x² - 0.07x + 9.1038
R² = 0.87908

y = 0.0003x² - 0.0122x + 4.312
R² = 0.73456

y = -0.0007x² + 0.141x - 2.2898
R² = 0.30662

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System 1 Design Features: Gen 1

- On RTU’s up to 130 tons
- 304 stainless steel cabinet
- Draining ventilation air coil
- 8” rigid media with edge coating
- Controls tailored to application
Example “Gen 1” DualCool Installation

Target – Woodland & West Sacramento CA
RTU Manufacturer - Lennox
RTU’s Installed – 12; 15 - 25 Ton
Example “Gen 1” DualCool Installation

Walmart – Lake Havasu NV
RTU Manufacturer - Munters
RTU’s Installed – 3- 30 Ton
Perspective:
Why hasn’t DualCool grown faster?

- Two widely-separated, short-term incentive programs
- Small company, owners had other opportunities
- No R&D support, slow evolution of design improvements
- Fortunate to have survived…
Generation 2 DualCool example
Gen 2 DualCool

Key Features:
- Standardized design
- “Unibody construction”
- Flexible connections
- Simple controls
- Rapid, safe installation
- Efficient submersible pump
- Shown on Davis Target store
Perspective:
Why don’t we have cooling ET’s?

- We haven’t funded as “distributed generation”
- Without such funding, major mgfrs don’t play
- We’ve offered “incentives” viewed as temporary gifts to build volume (then no longer needed?)
DualCool Status

- Performance well-proven
- Gen 2 design ready to produce
- Volume pricing structure in place
- Current focus on chain retail
- Working now on 14 store Walmart order
Chain Retail Economics Example

- 20 RTU At 105F peak condition
- 30% outdoor air (2400 cfm)
- Base case capacity 222 kBtuh
- DualCool capacity 304 kBtuh
- Cut 1 compressor> 240 kBtuh
- Demand reduction 8.8 kW
- At $800/kW, incentive buys the system
- Energy savings are then a bonus to the owner…
Economizers are a major opportunity for “continuous commissioning” performance improvement.

Economizer damper setting must be adjusted on completion of DualCool installation to compensate for ventilation coil pressure drop.

Opportunity: Extended economizer cycle- pre-cooled vent air allows economizer operation at higher outdoor air temperatures; sensor placement critical.
Commissioning Links - Blower Speed

- In most California RTU applications, the blower uses more kWh annually than the compressors do.
- At increased capacity from DualCool features (lower condensing temperature, pre-cooled vent air), blower speed can be reduced and still meet the peak load.
- Reducing blower speed offers “cube law” savings and reduces load as well.
- Adjusting blower speed should be a commissioning task (requires resetting fixed-speed blower sheave).
Commissioning Links-Condenser Fans

- DualCool velocity must be limited to 400 fpm, which may require reducing condenser airflow
- Condenser fans are most frequent RTU failure item
  - Many RTU’s have multiple condenser fans
  - Pre-cooled air allows lower condenser airflow
  - VFD on the array, or “block and disable” can save kWh
- Condenser fan savings help, but less than blower savings
Commissioning Links: Compressor Lockout

- DualCool capacity boost invites “takeback” that limits demand savings.
- RTU’s 6 tons and larger have multiple compressors.
- Best strategy to maximize demand savings is to disable compressors to return to base case capacity.
- This strategy leaves replacement compressors available at the job site.
Commissioning Links: Why Bundle with DualCool?

- DualCool requires reliable adjustment of many RTU components
- Commissioning team more likely than an installation crew to have the required “tuning” expertise
- Commissioning report lends added credibility that is valuable to owners and incentive sponsors
- Larger benefits from bundling create more positive responses and more rapid implementation
Commissioning Links: Why Bundle with DualCool?

- Other Reasons???
- (This slide intentionally left blank…)
Integrated Comfort Inc.

- Company formed 1992 to market the CoolRoof system
- Lance Porter purchased ICI in 2007
- 72,000 sq. ft. of manufacturing space
- Facility shared with All-Weather Manufacturing, Vacaville CA
- 12 year-old building with award-winning NightSky installation – radiates heat to the night sky, reducing cooling energy use by 70% & peak demand by 87%