# IMPROVING ENERGY EFFICIENCY IN COOLING TOWER DESIGN

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AN SPX BRAND

GLOBAL INFRASTRUCTURE X PROCESS EQUIPMENT X DIAGNOSTIC TOOLS

SPX
WHERE IDEAS MEET INDUSTRY

- 39% of total energy use*
- **70% of electricity consumption***
- HVAC accounts for 40-60% of the energy used in US commercial & residential buildings**

* source Gulf news June 2005 and Statistics provided by USGBC's LEED for Product Manufacturers presentation, ©2005

**Statistics provided by US Department of Energy: Buildings info and components

- Utilize water cooled chiller design
- Optimize the chiller performance
- Minimize the chiller operation
- Optimize the cooling tower efficiency
  - ASHRAE 90.1
  - ASHRAE 189.1
  - Proper tower selection
  - Proper tower operation

# Step 1:
# Utilize Water Cooled Systems

## Water vs. Air Cooled Systems

- Lower condensing temperatures
- 1.5 to 3 times greater COP than air cooled
- 30 to 50% potential energy savings
- By far the largest opportunity to reduce energy usage

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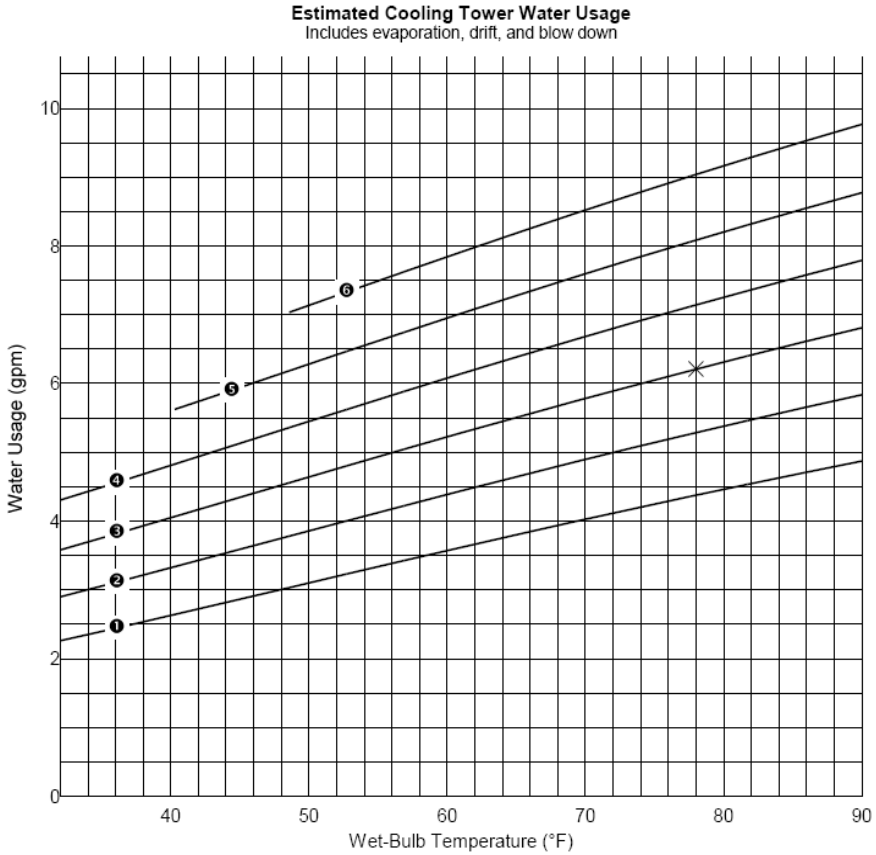
## When Are Air Cooled Systems Appropriate?

- Below 300 tons
  - California Title 24 allows 100% air cooled systems under 300 tons
  - Payback favors dry cooled below ~200 to 300 tons
  - Various ASHRAE studies
  - However, water cooled systems still more efficient
- Limited water availability
  - Water usage is frequently over-estimated

# Water Usage Curves




**Design Conditions**

| | |
|---|---|
| Tower Water Flow | 400 gpm |
| Hot Water Temperature | 95.00 °F |
| Cold Water Temperature | 85.00 °F |
| Wet-Bulb Temperature | 78.00 °F |
| Drift Rate | 0.005 % |
| Concentrations | 3 |

**Legend**

- ❶ 6 °F Range
- ❷ 8 °F Range
- ❸ 10 °F Range
- ❹ 12 °F Range
- ❺ 14 °F Range
- ❻ 16 °F Range
- × Design Point

Information provided from UPDATE Sizing and Selection Software from SPX Cooling Technologies

## Water Saving Strategies

- Hybrid wet/dry cooling tower
  - NCWD
  - Utilizes sensible and latent cooling
- Increase cycles of concentration
- Make-up water alternatives

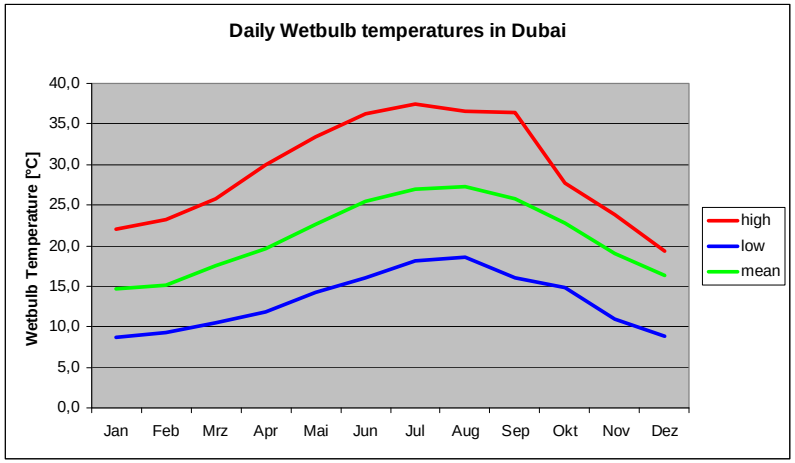
## No Water?

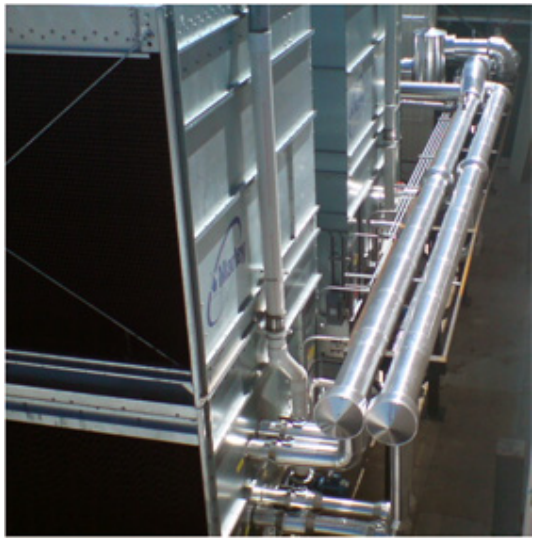
> Must use a dry system

# Step 2:
# Optimize Chiller Condenser Temperature and Range

## Optimize Chiller Performance

- 2 vs. 3 GPM per ton
- Design cold water temperatures as low as possible
  - Efficiency improves 1 to 3% for every 1°



## Optimize Chiller Performance

- 7° F approach temps are typical (=3,89° C)
- 5° F is feasible and reasonably common (=2,78° C)
  - Lower chiller operating cost
- Approach temp is proportional to capacity
  - Example: Reducing the approach temp from 7° F to 5° F equates to 29% increase in required tower capacity

# Step 3:
# Optimize Cooling Tower Efficiency

## ASHRAE Standard 90.1 (2004)

- Meet the minimum base case 90.1 for the entire building
  - CTI certified 38.2 GPM/hp for axial fan open cooling towers (=11,6 m³/h/kW)
  - CTI certified 20 GPM/hp for centrifugal fan open cooling towers (=6,1 m³/h/kW)

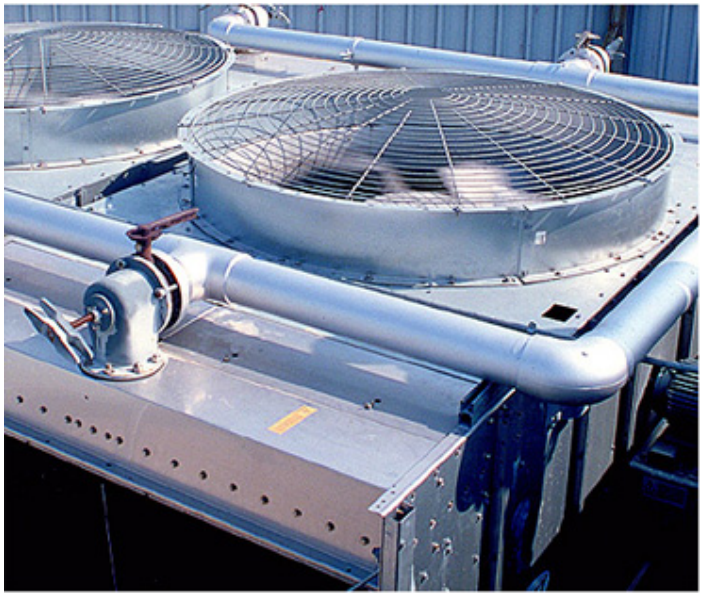
## ASHRAE Standard 90.1 (2010)

- Looking to achieve 30% energy savings over previous version
- Part of ASHRAE's goal to achieve market-viable net-zero energy buildings by 2030
- Efficiencies defined for Evaporative Fluid Coolers
- Centrifugal fans will have same requirements as axial fans

## Axial vs. Centrifugal Fans

- Axial fans are  two times more efficient than centrifugal

- Centrifugal-forced draft towers still viable:
  - Indoors
  - Ducting
  - Replacements



## Increase 90.1 Efficiency Requirement

- Increase 90.1 efficiency requirement
  - Double the minimum efficiency from 38.2 to 76.4
  - Does not always increase the tower cost
- UPDATE sizing & selection software
  - http://qtcapps.ct.spx.com

| Actions | Model | Cells | Status | Fan Motor Output BHp | Total Fan Motor Output BHp | Capacity | Cost Ratio | ASHRAE 90.1 Perf. gpm/Hp | Fan Energy Cost $ | Pump Energy Cost $ | dBA Single Cell |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NC8301E1 | 1 | | 10.0 | 10.0 | 98.4% | 0.99 | 60.6 | 855 | 184.3 | 78 |
| | NC8301EL1 | 1 | CTI | 10.0 | 10.0 | 100.2% | 1.00 | 61.8 | 838 | 184.3 | 75 |
| | NC8302DL1 | 1 | CTI | 7.5 | 7.5 | 110.4% | 1.00 | 90.7 | 573 | 184.3 | 72 |

# Step 4:
# Operate Cooling Towers Efficiently

## Energy Efficient Operation

- Using Variable Frequency Drives
  - Method of control
  - Example:  10 cell cooling tower (100hp/cell) 1000 hp total at 50% heat load
    - Operating with 5 cells on full speed = **500 hp**
    - Controlling 10 cells together (ramping all fans up and down together by VFD) = **125 hp** to meet the same duty.

## Energy Efficient Operation

- Using Variable Frequency Drives cont.
- Crossflow towers are ideal varying flow rates throughout the year
  - Readily handles multiple flow rates through the use of basin dams

# Step 5:
# Responsible Cooling

## Proper Water Management

- Develop and implement a water management plan for the cooling tower
- Improve water efficiency by installing and/or maintaining a conductivity meter and automatic controls to adjust bleed rate and maintain proper concentration

## Proper Water Management

- Have a measured program in place that verifies make-up water quantities used from non-potable sources

- Acoustics – reduce sound levels
  - Attenuation, Low Noise and Ultra-Low Noise Fans

Questions?