Consideration of the Environmental Impact of Wet vs Dry Cooling

Air Cooled Condenser Users Group

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Andrew Howell

Xcel Energy®

Air Cooled Condenser Applications

- Initially applied in water-deficient regions of the world:
  - South Africa
  - Australia
  - Western United States
  - China
- Recent installations in areas with plenty of water, due to environmental regulations limiting water use.

State of California:

"No once-through cooling with seawater" (2010)

- recirculating evaporative cooling towers technically still allowed, but --

Update to rule 316(b) of the Clean Water Act

Previous mitigation requirement applied to units with intake > 50 MGD (~75 MW steam turbine with once-through cooling)

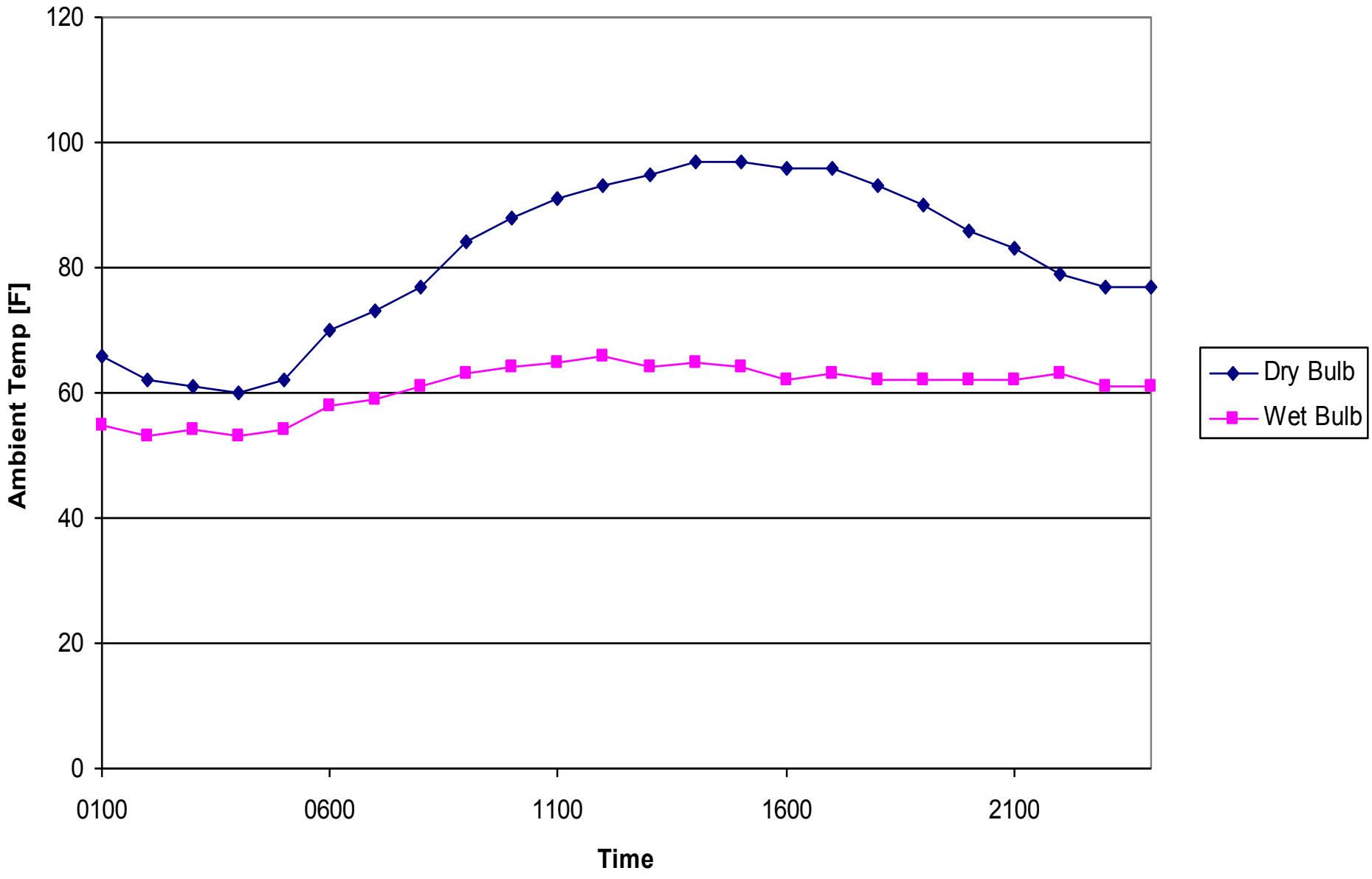
Mitigation actions now required for facilities with intake design greater than 2 MGD (~150 MW steam turbine with recirculating evaporative cooling towers)

ACCs in Eastern US

- ~ 21 (at least 4 additional by 2017)
- Since 1991; most since 2000
- New York case
- Maryland case

ACC Cooling Inefficiency vs. WCC in Hot Weather

Dry bulb vs. Wet bulb Temperature



ACC Inefficiency Results in Higher CO_2 Emissions

- Lower vacuum with ACC in hot weather, compared with water-cooled condensers, decreases steam turbine efficiency, requiring more fuel consumption for the same generating output.

  - More fuel burned = more CO_2 emissions.

ACC Inefficiency Results in Higher CO_2 Emissions

- In the hottest ambient conditions, condenser vacuum typically is inadequate for unit to achieve full generating capacity – 10 to 15% reduction in electricity output from the steam turbine.

This shortage of electric power must be made up from other, less efficient power plants.

Study Results, California Energy Commission (combined cycle plants)

- On a year-round basis, dry cooled plants would produce 854 lbs of CO_2 per MW-hour, and wet cooled plants produce 840 lbs per MW-hour, or a 1.6% increase in CO_2 emissions with dry cooling.
- On "hottest days," dry cooled plants produce 5.3% more CO_2 than wet cooled plants, and lose 4.1% of generating capacity.
- Impact for coal-fired plants is approximately twice as great (entire impact is steam turbine).

Long Term Planning

- Dry cooled plants are good for water savings, but not ideal for limiting CO_2 emissions.
- The amount of CO_2 increase may not seem large (about 3 - 4% for coal-fired plants), but environmental pressure in the future may cause these plants to shut down earlier than intended.

Improvement of Dry Cooling Efficiency

- Use water intermittently during hottest weather.
  - Parallel wet-dry condenser
  - Spray systems
  - Indirect dry cooling (Heller) with water spray option
- These require some water: potential sources - recycled waste water, ocean water, freshwater source with restricted availability, ???

Conclusions

- Dry cooling is less efficient than wet cooling and results in higher CO_2 emissions
- Designs to use limited water quantities in the hottest weather to achieve better condenser vaccuum can reduce CO_2 emissions and should be considered in any new ACC design