

Environmental Aspects of Advanced Generation in California



California Energy Commission – PIER

PIER Advanced Generation Program

IEPR Staff Workshop on
RD&D of Advance Generation Technologies
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Water Use for Electricity Generation
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Overview

- Why is power plant water use important?
- How do power plants use water?
- Cooling technologies and tradeoffs
- PIER research



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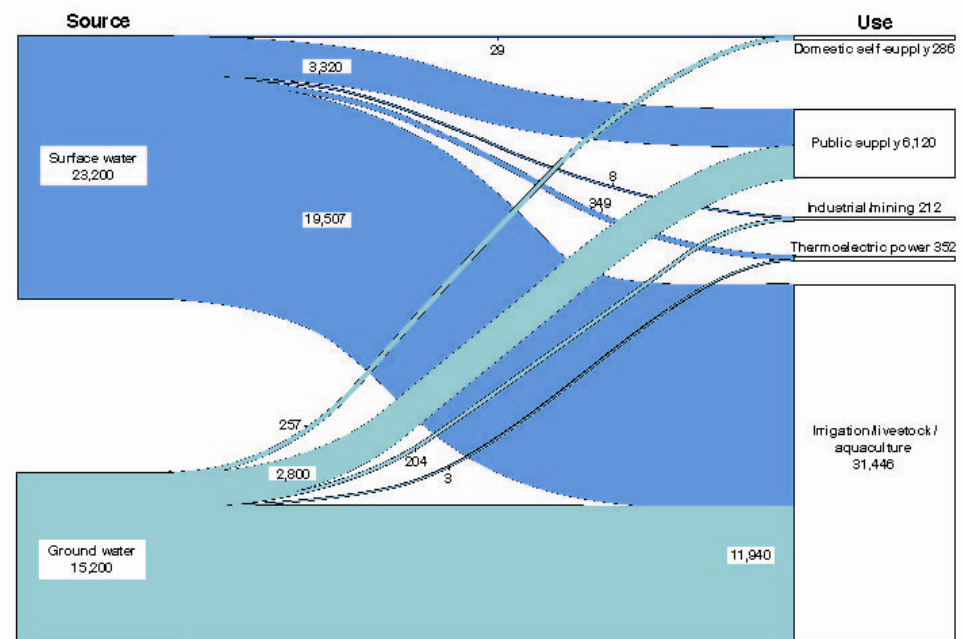


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Why is power plant water use important?

- California's limited freshwater resources are increasingly being stressed by a warming climate and population growth.
- The large volumes of water used by power plants using once-through cooling technology has raised concerns over biological impacts
- Water consumption by power plants is not significant on a statewide basis
- Can be significant on local or regional basis
- Reducing the effects of energy generation on water can reduce environmental damage and ensure energy reliability.

Figure 2. Estimated California Freshwater* Withdrawals in 2000: 38,400 Mgal/day



Source: U.S. Geological Survey, Circular 1268, Tables 1-4.
In addition, 12,800 Mgal/day of saline water was withdrawn, primarily for thermoelectric power purposes.
Note: Numbers shown may not add to totals because of independent rounding.

Lawrence Livermore National Laboratory, May 2004
<http://eed.llnl.gov/fow>

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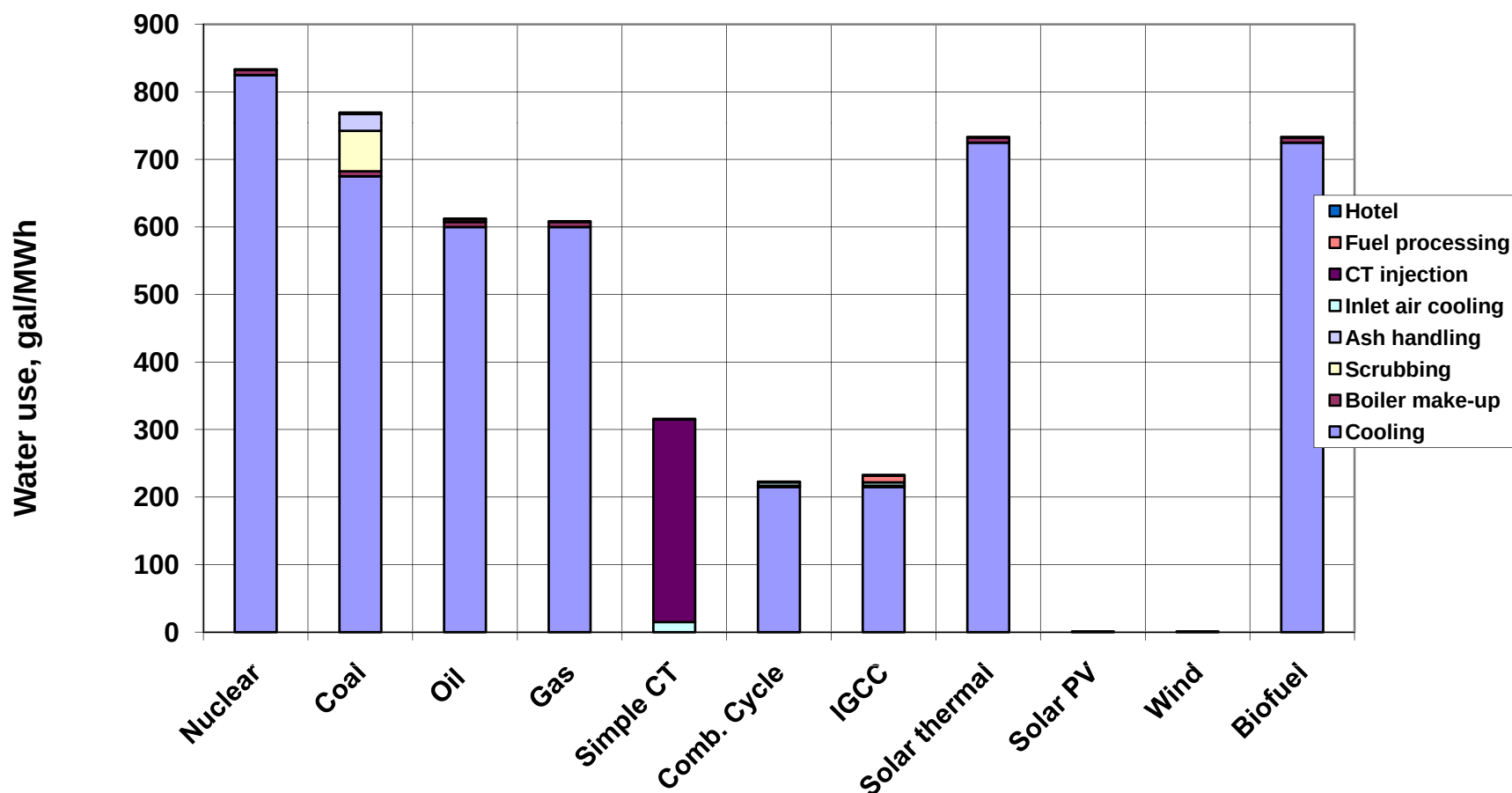


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How does a power plant use water?

Cooling (steam condensation) can represent 90% or more

Water Requirements by Plant Type



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How can we use less water?

- Degraded water sources
- Water conserving cooling technologies



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Degraded water sources

Sources

Wastewater effluent

Produced water from oil & gas extraction

Irrigation return flows

Contaminated/saline groundwater

Challenges

Consistent water availability
and quality

Treatment costs

Transportation costs

Heat transfer surface

Scaling & corrosion

Disposal

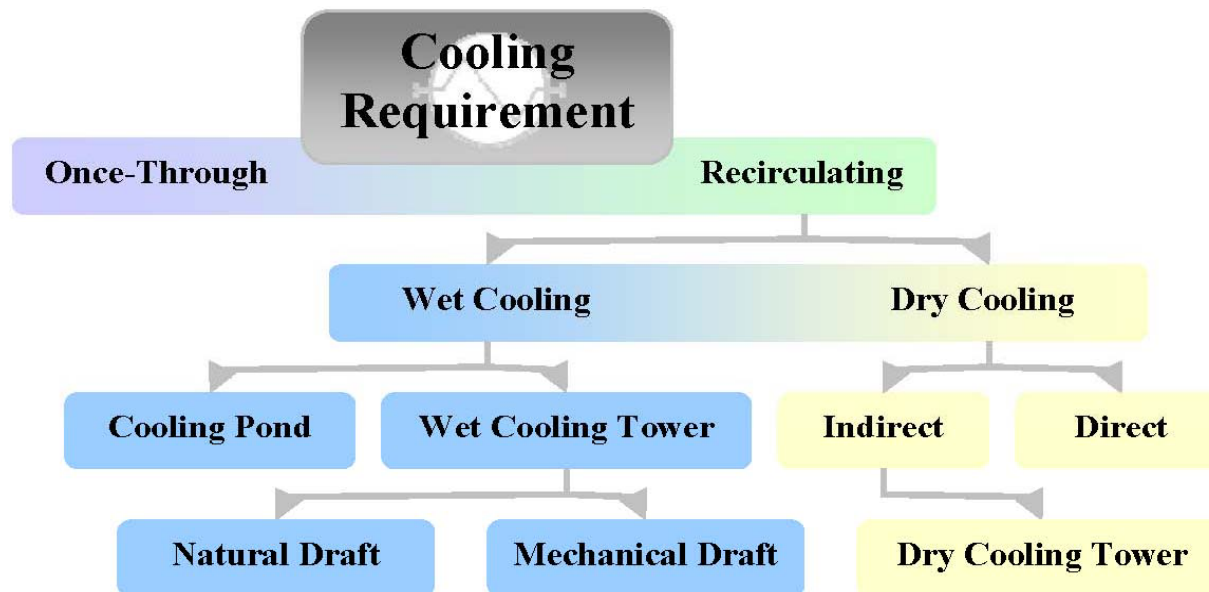
Drift/health



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Source: NETL 2008

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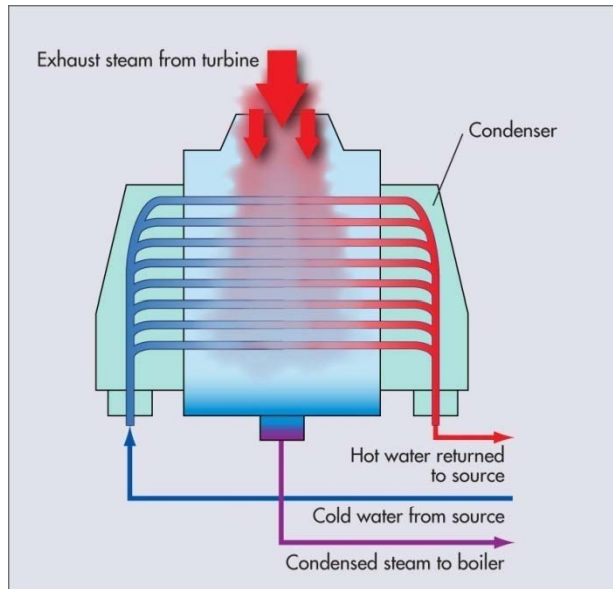
Once-through Cooling

Pros:

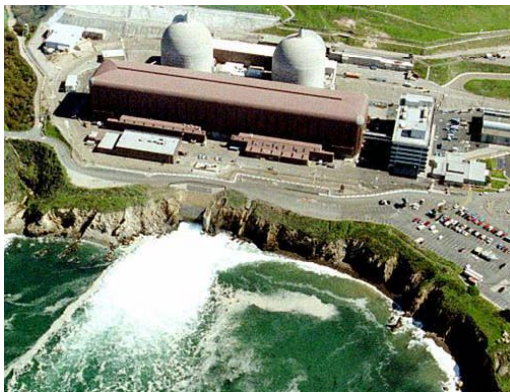
- High cooling efficiency, especially in areas with cold water
- Lower consumptive use of water
- Mature technology

Cons:

- State Water Resources Control Board Policy
- Clean Water Act 316(b) Rules for fish protection
- CWA 316(a) thermal discharge limits, especially in drought conditions



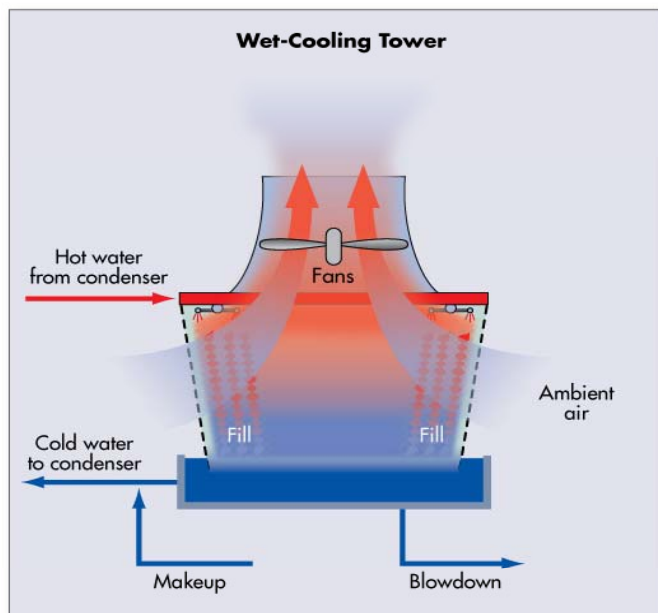
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Wet Cooling Towers

Pros:

- Substantially less water withdrawal than once-through
- System of choice for most plants
- Mature technology

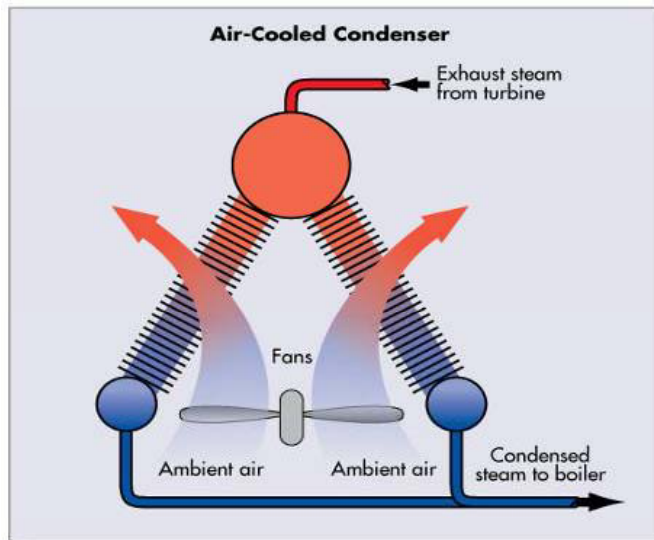
Cons:

- Higher consumptive use of water
- Higher parasitic load
- Lower plant efficiency
- Blowdown
- Plume and drift issues

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Dry Cooling

Pros:

- No water consumption
- Eliminates plume/drift issues

Cons:

- Higher capital cost
- Higher power consumption
 - Lower plant efficiency
 - Hot weather impacts
 - Large space requirement
 - Wind effects

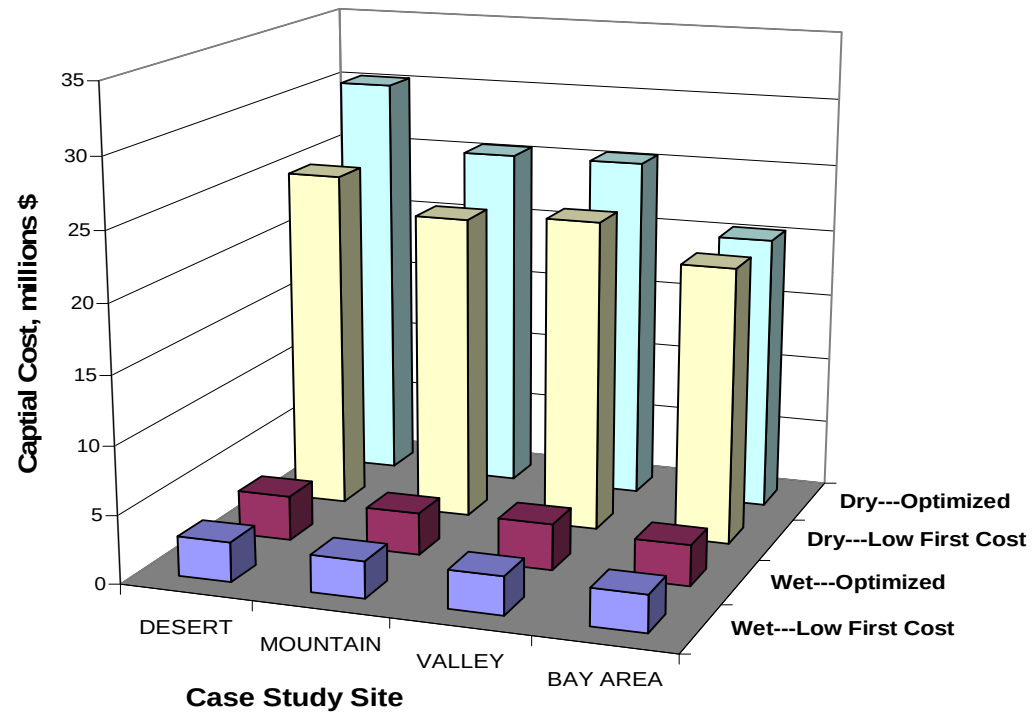
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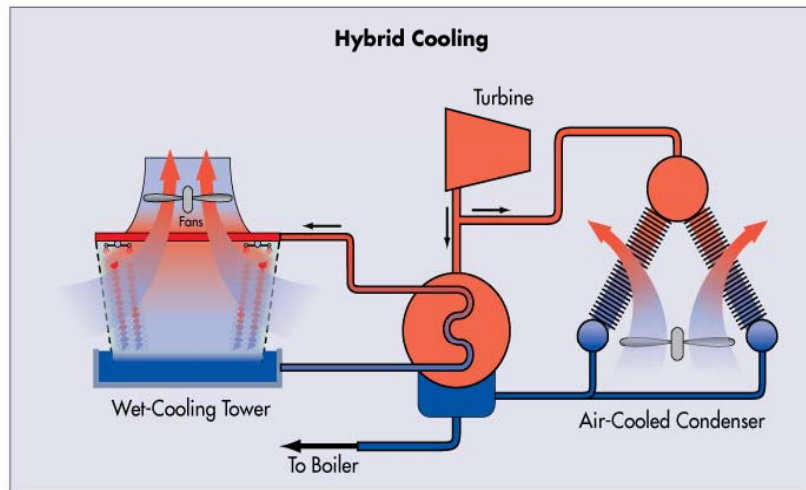
Case Study Cost Summary



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Hybrid Cooling

Pros:

- Cheaper (than all dry) capital costs
- 1/3 to 2/3 less water use
- Elimination of hot day penalty
- Flexible operation: energy conservation vs. water conservation

Cons:

- Still uses water
- Capital costs greater than wet
- Limited experience
- Same issues as wet and dry systems



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Research

- Spray-enhancement of air-cooled condensers
- Reduce wind effects on air-cooled condensers



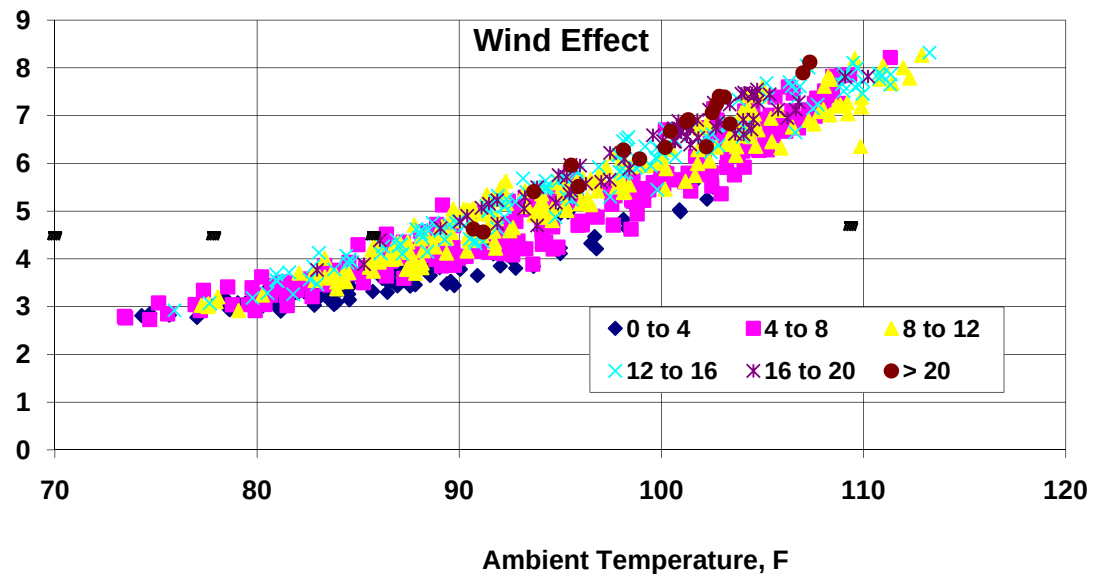
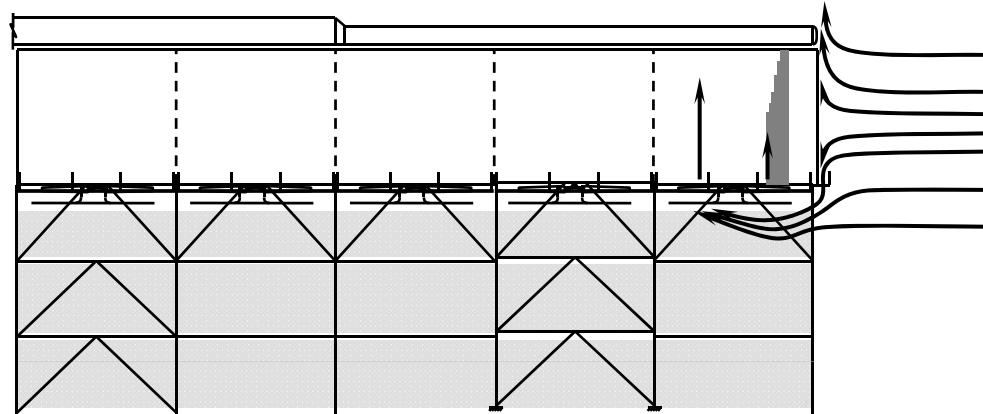
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Wind Effects on Air-Cooled Condensers

Wind can affect the performance of dry cooling systems by causing the recirculation of the hot exhaust plume back into the condenser or by reducing fan performance.



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- Questions?

