Performance Enhancement for Air-Cooled Condensers

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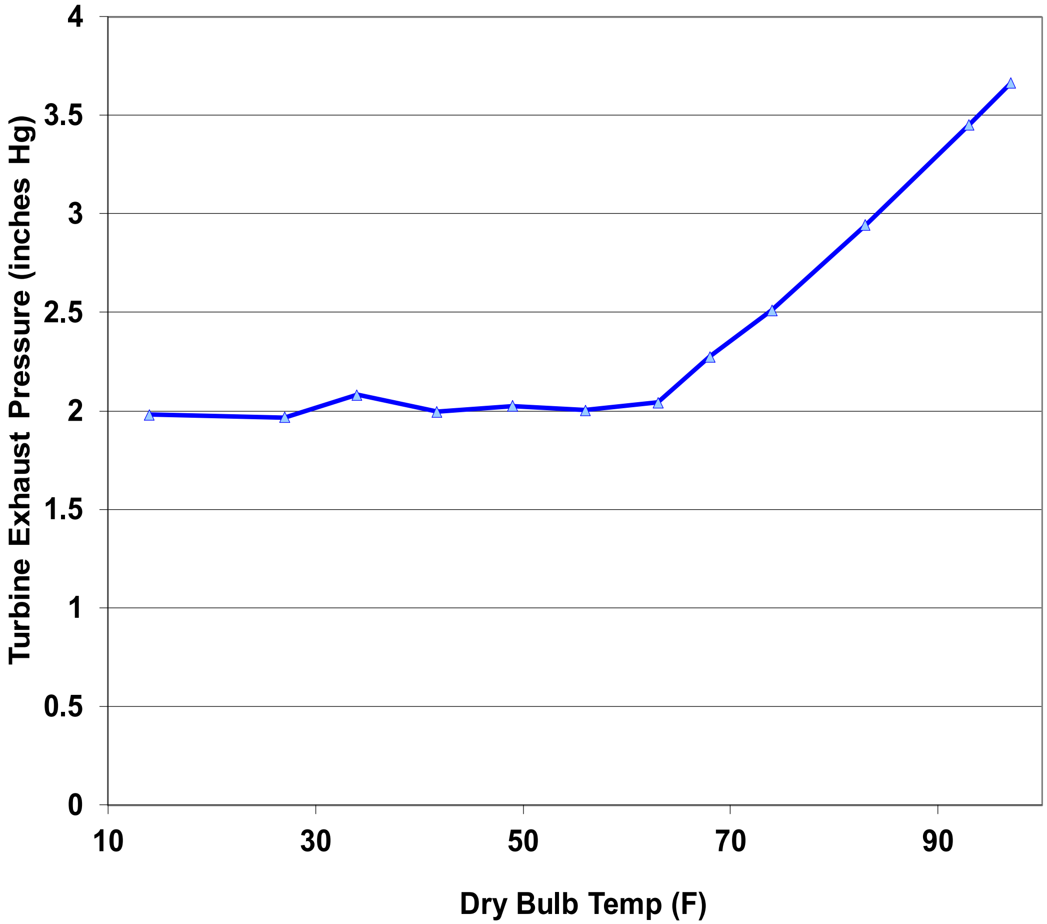
Existing U.S. Power Plant Cooling Technologies

Based on MW generation (includes nuclear, excludes CC combustion turbine [21% of total MW])	%
Evaporative cooling tower	51
Sensible cooling (once-through)	46
Dry cooling (direct ACC)	1.8
Hybrid cooling (ACC + wet cooling tower)	0.5
Other	0.6

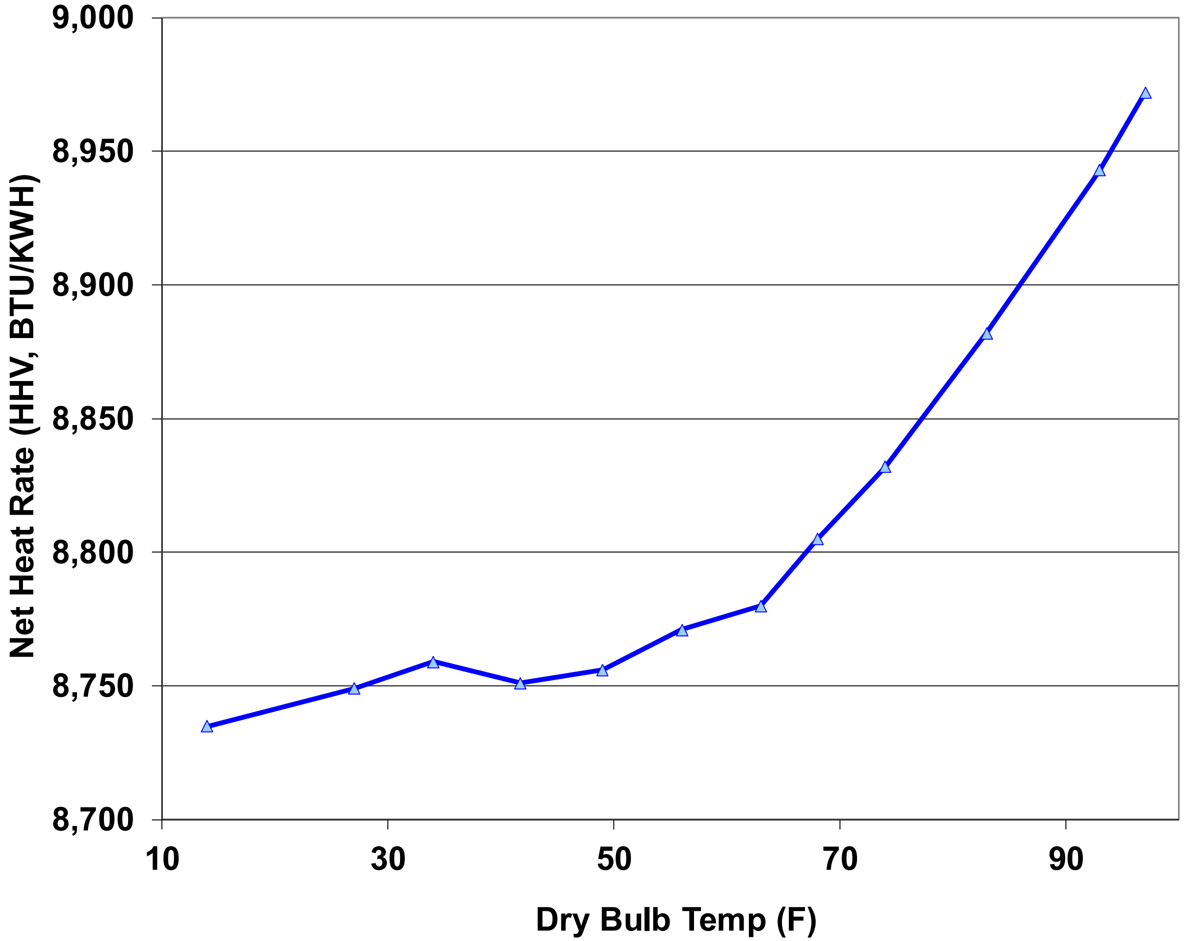
Source: U.S. Energy Information Administration, 2017

Direct-condensing, forced-draft ACC

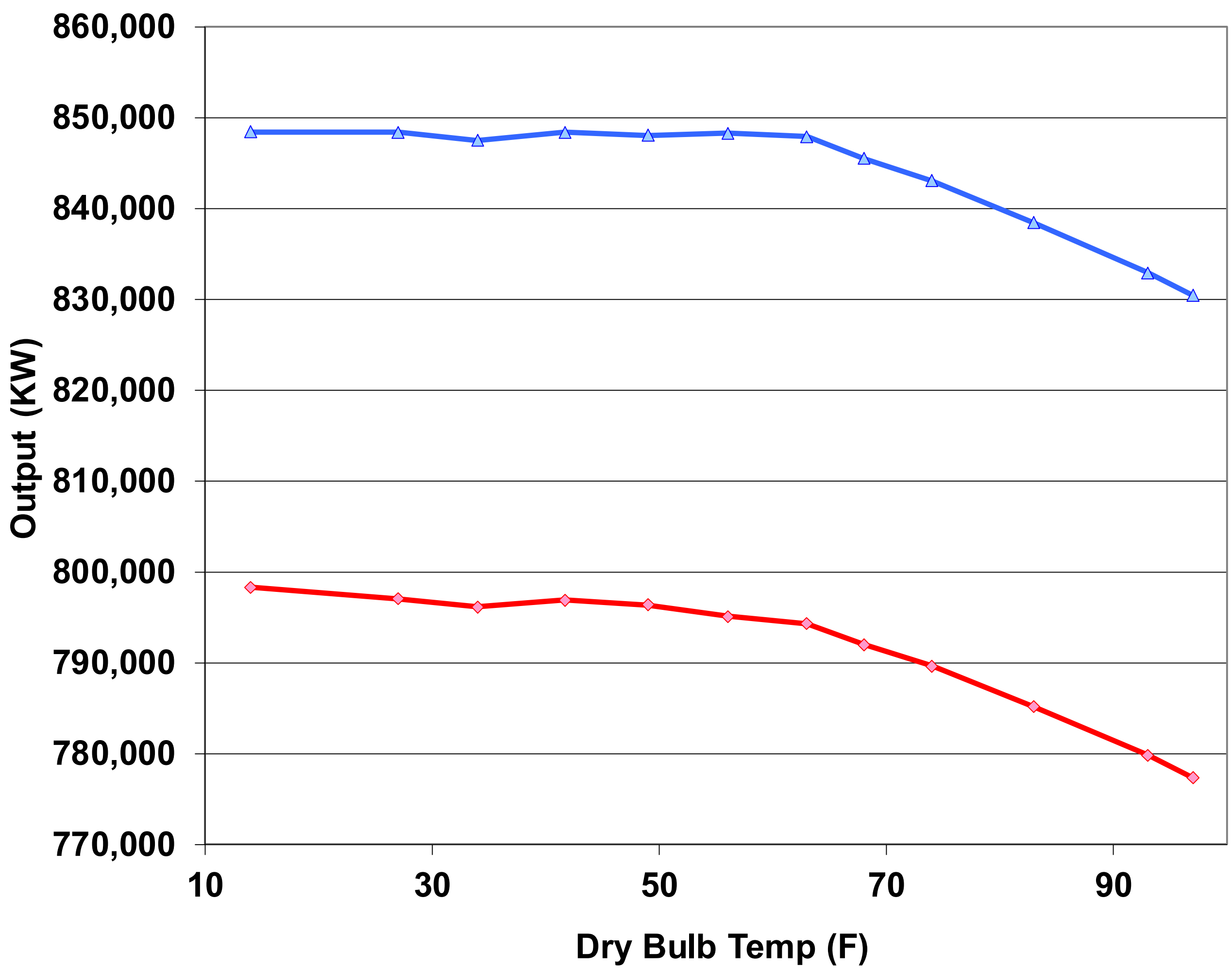
Ambient T vs. Condenser Backpressure



Ambient T vs. Fuel Efficiency



Ambient T vs. Generation Output



Sources of Dry Cooling inefficiency (direct condensing ACC)

1. Heat transfer from steam to cooling air

2. Ambient air temperature

3. Power draw from large fans

Other:

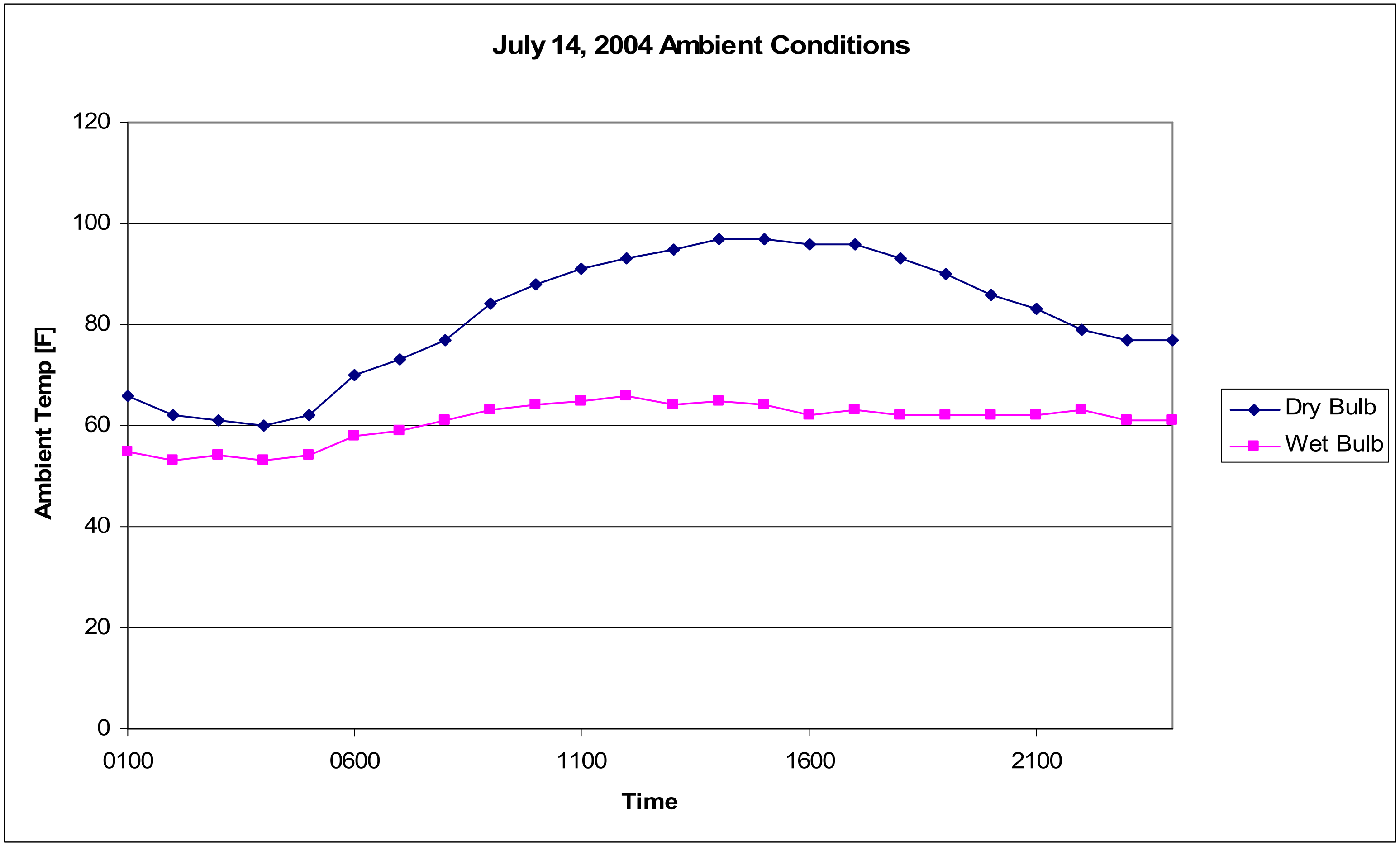
- airside debris accumulation on finned tubing
- air inleakage
- wind / hot air recirculation
- gaps / air bypass
- fin damage

Air-Cooled Condensers require a large surface area

Source: B&W SPIG

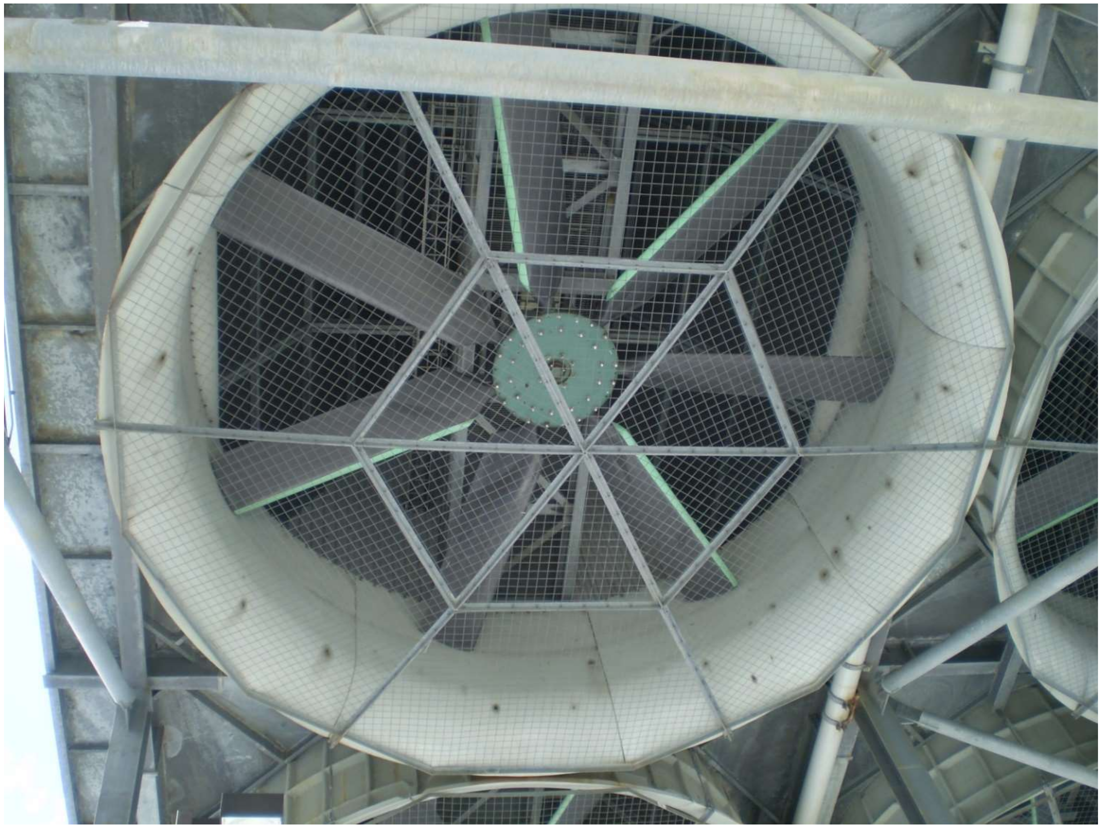
Air-Cooled Condensers require a large surface area

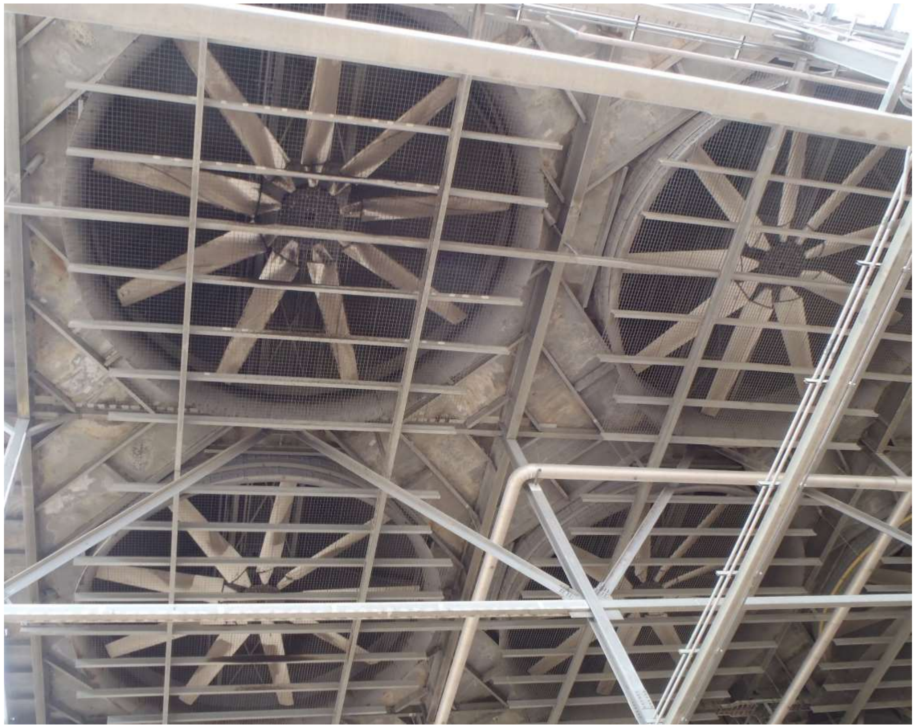
Design Day: dry bulb vs. wet bulb T



Large fans with significant power draw

500-MW steam turbine may require 10 MW to run cooling fans





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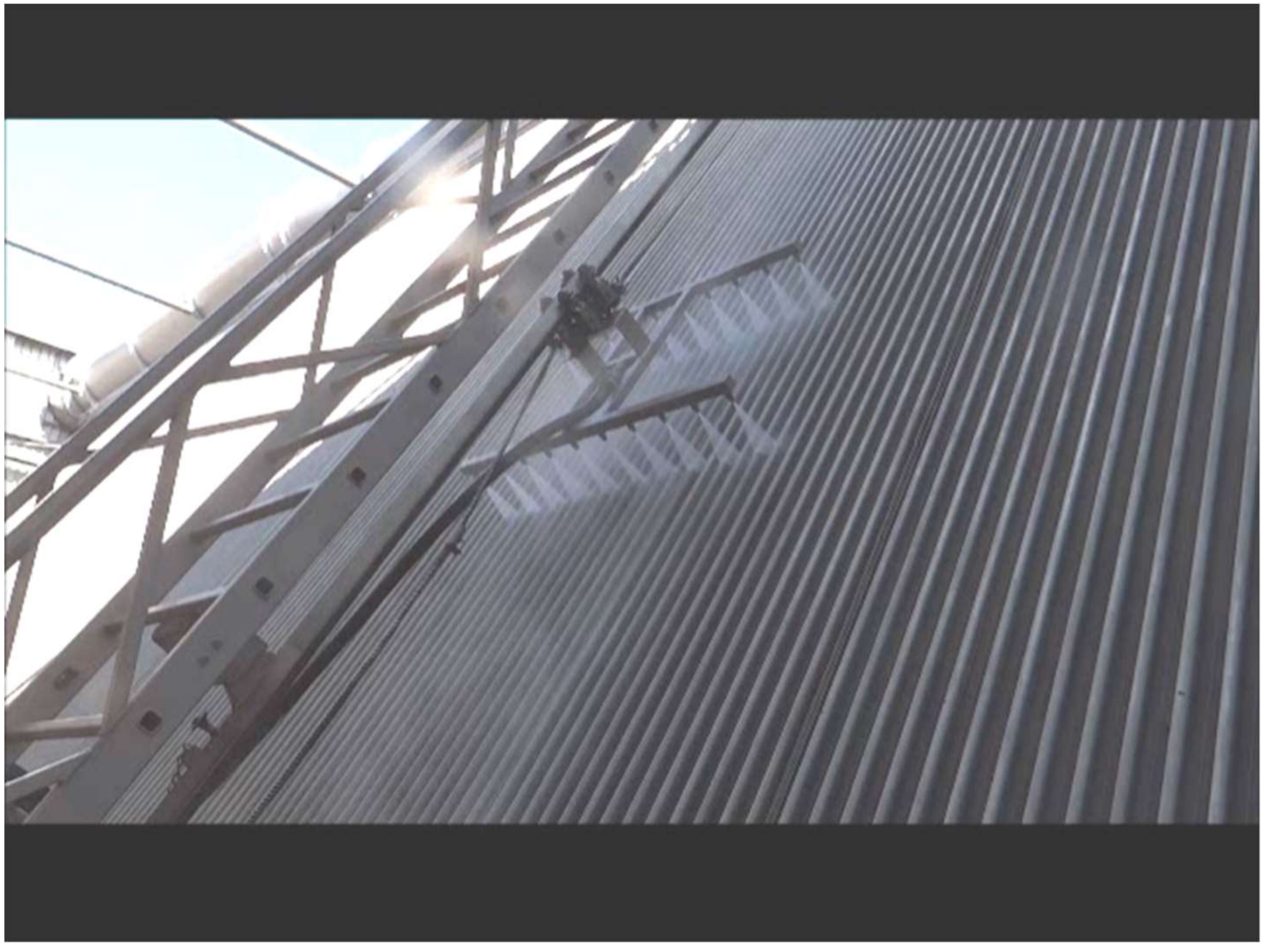
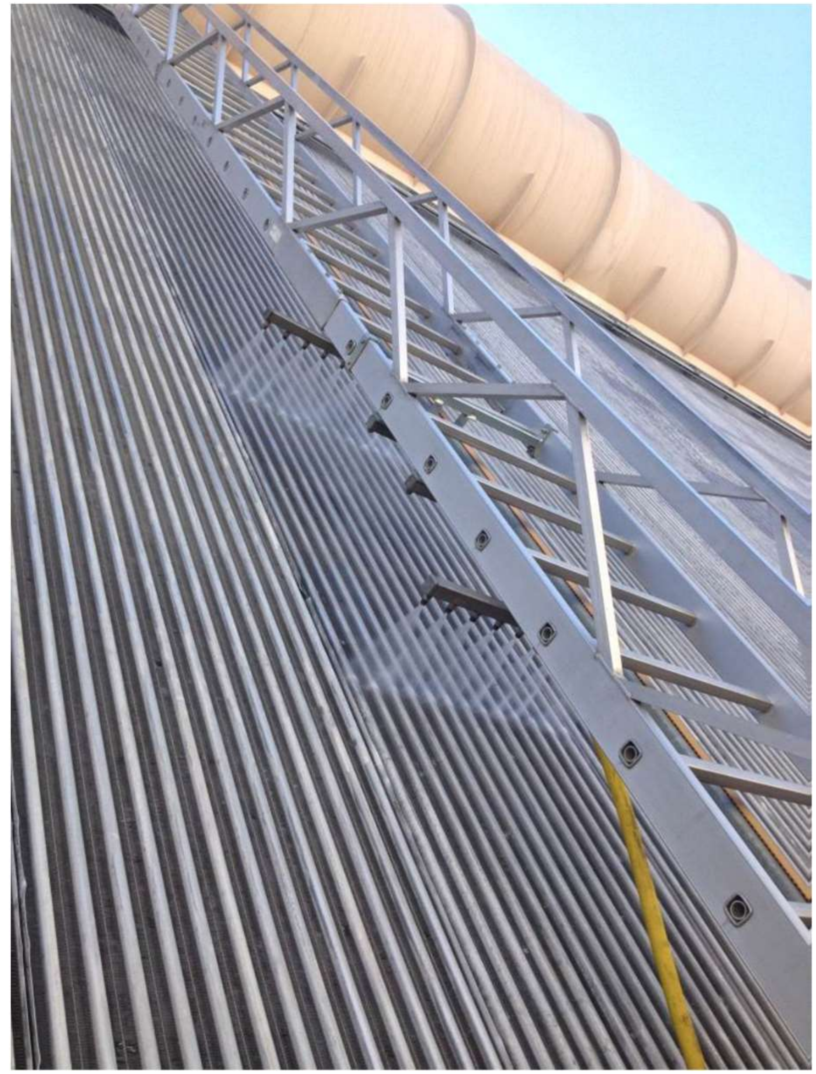
Finned tube fouling

Finned tube water washing

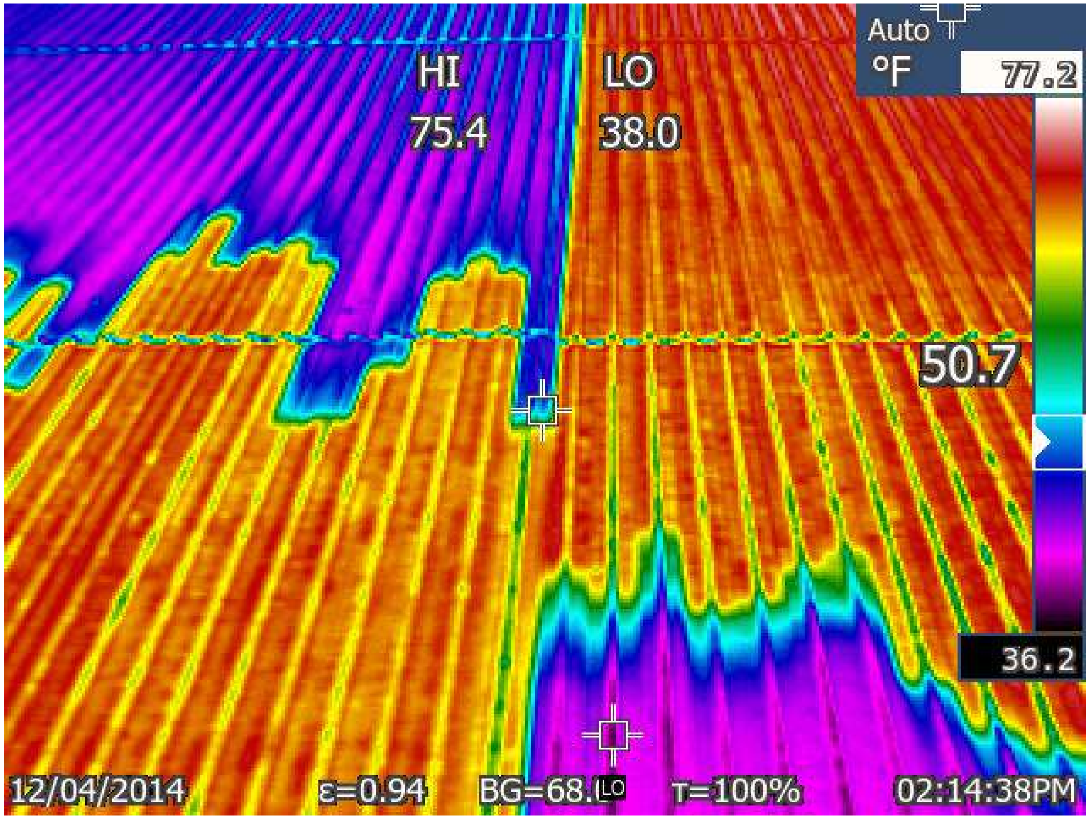


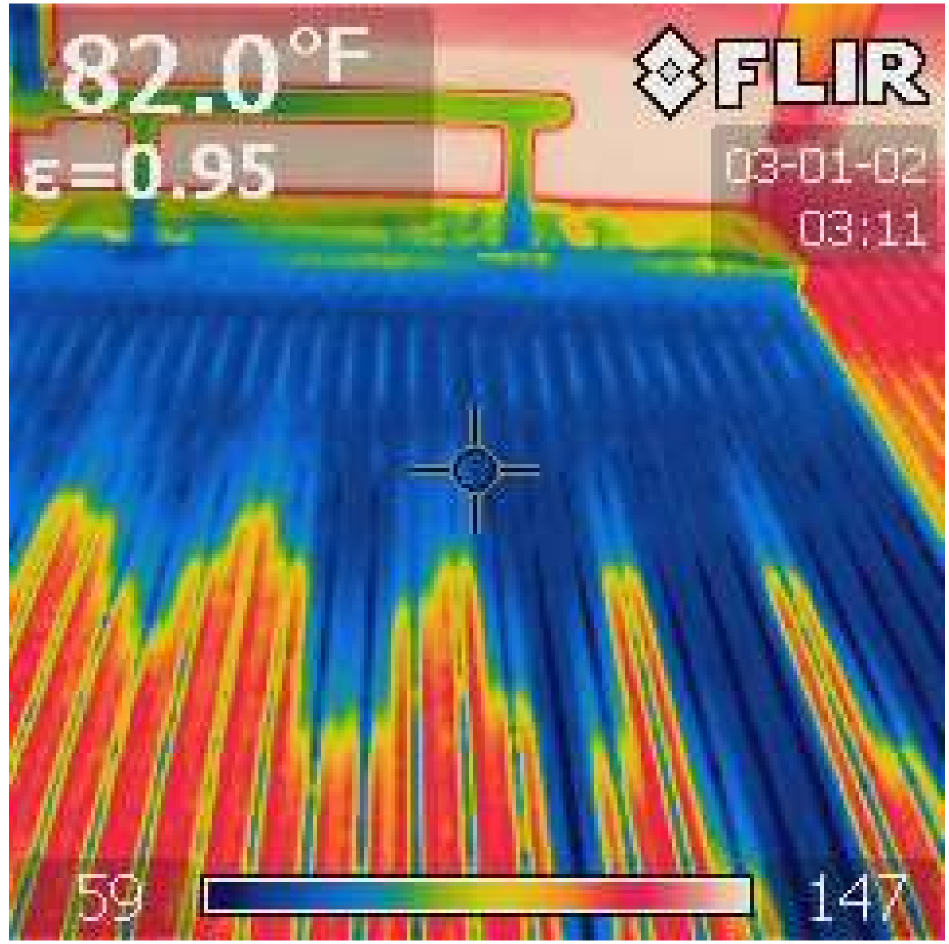


Finned tube water washing

Air Inleakage

Air binding identified by Infrared thermography





Source: M. Cyr, ACCUG 2015

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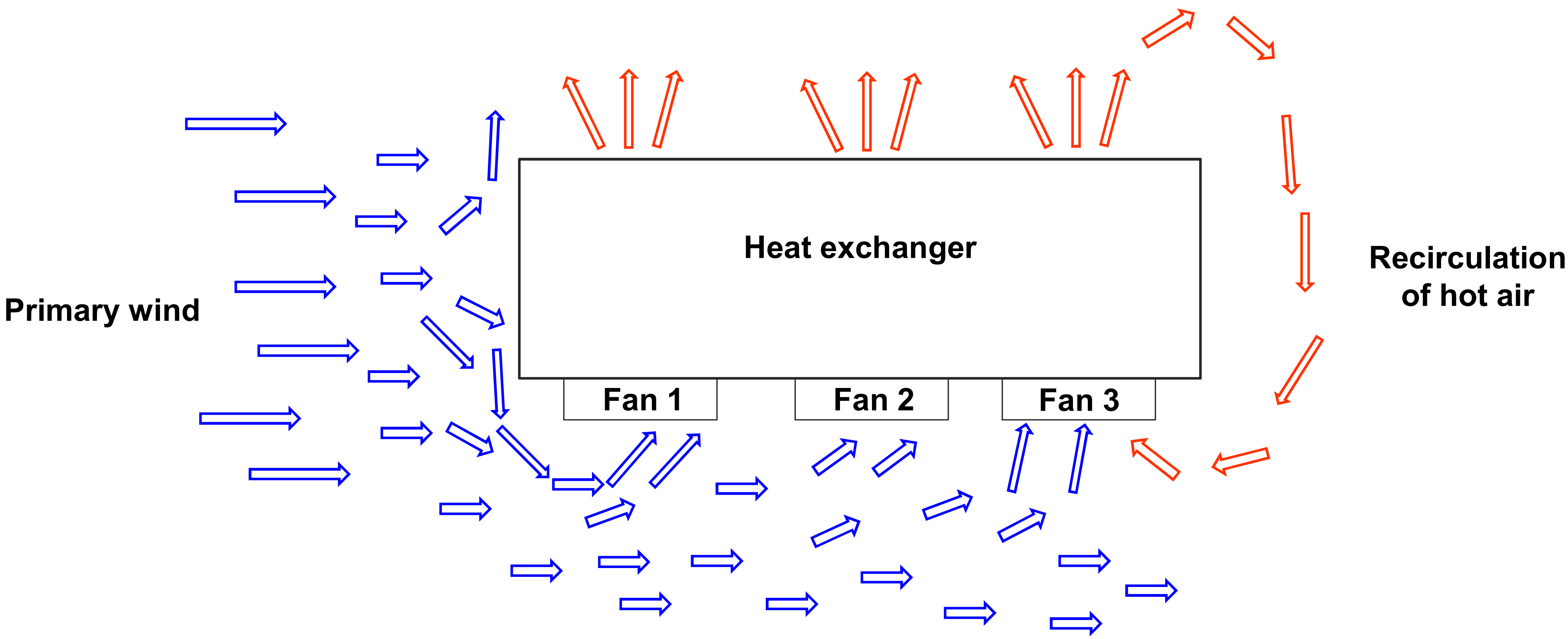
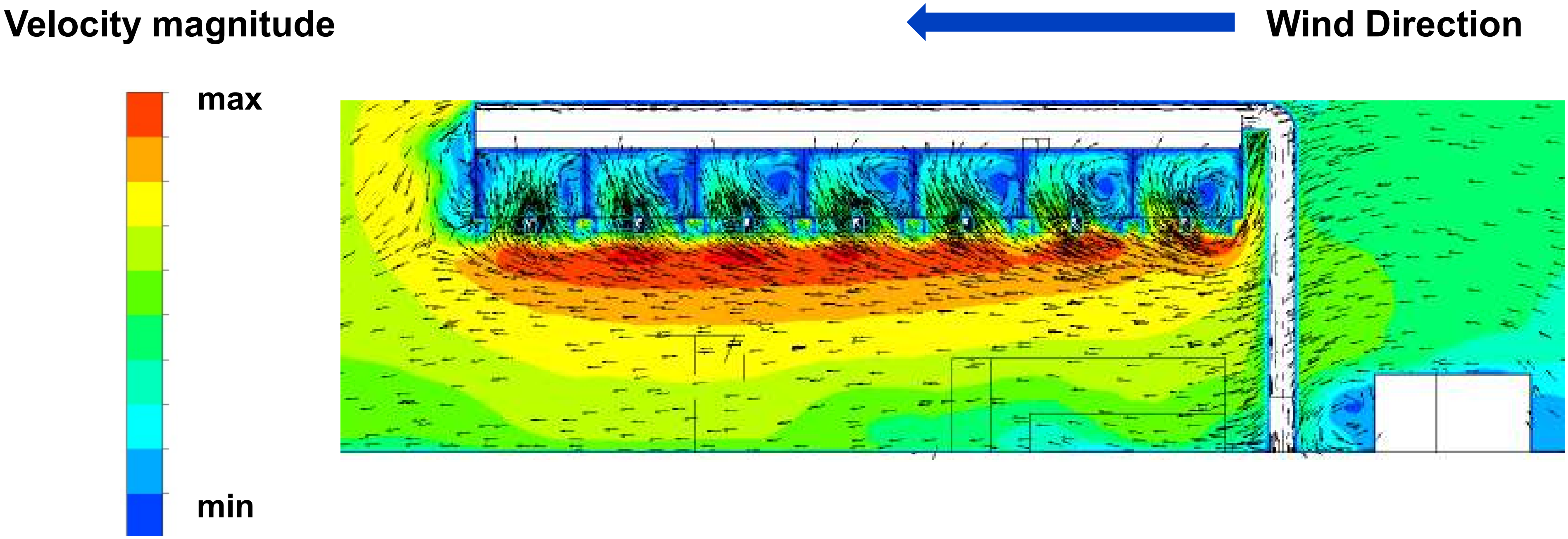
Hot Air Recirculation



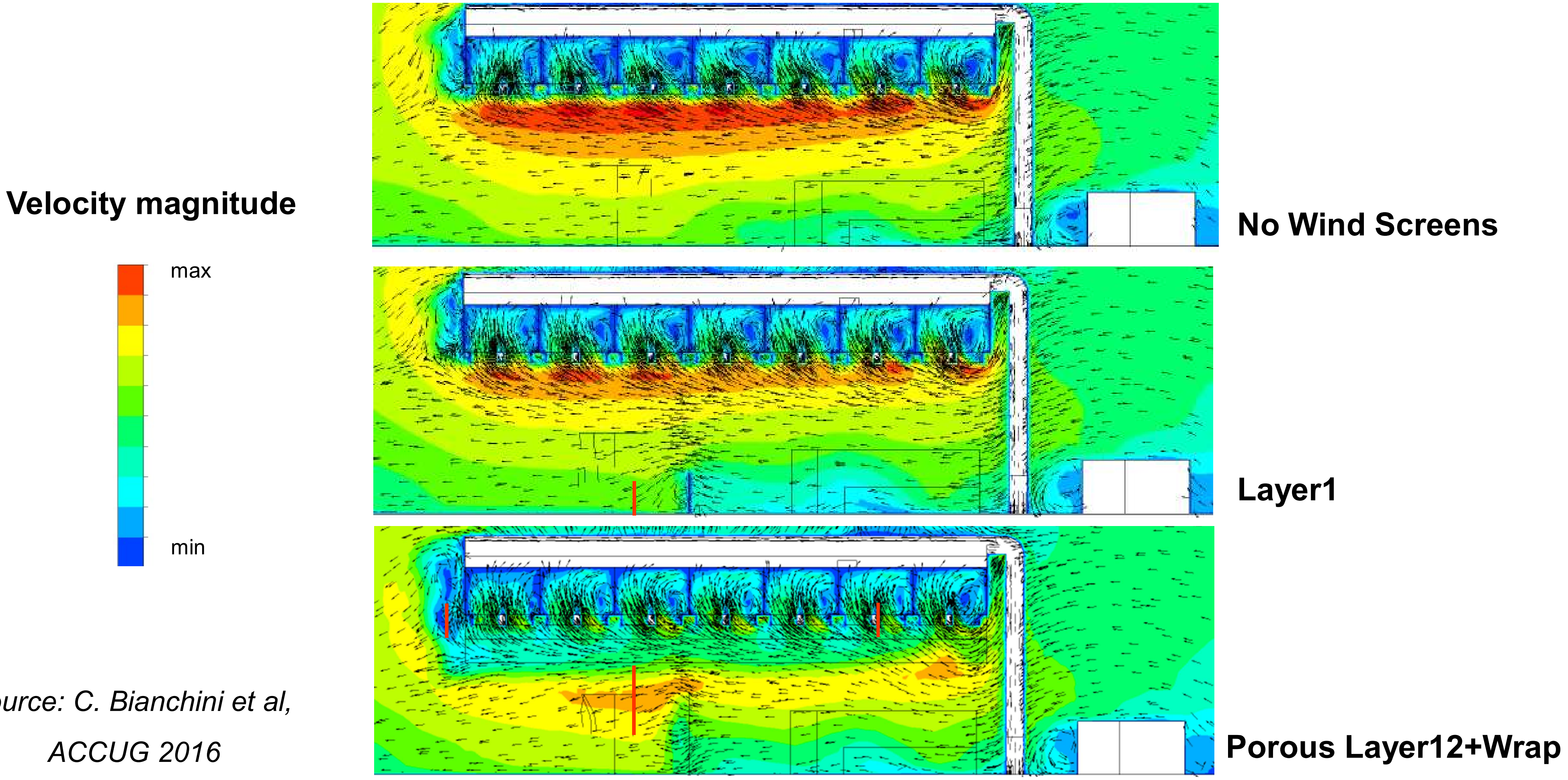
Source: C. Bianchini, ACCUG 2017

Wind effects on airflow: CFD modeling



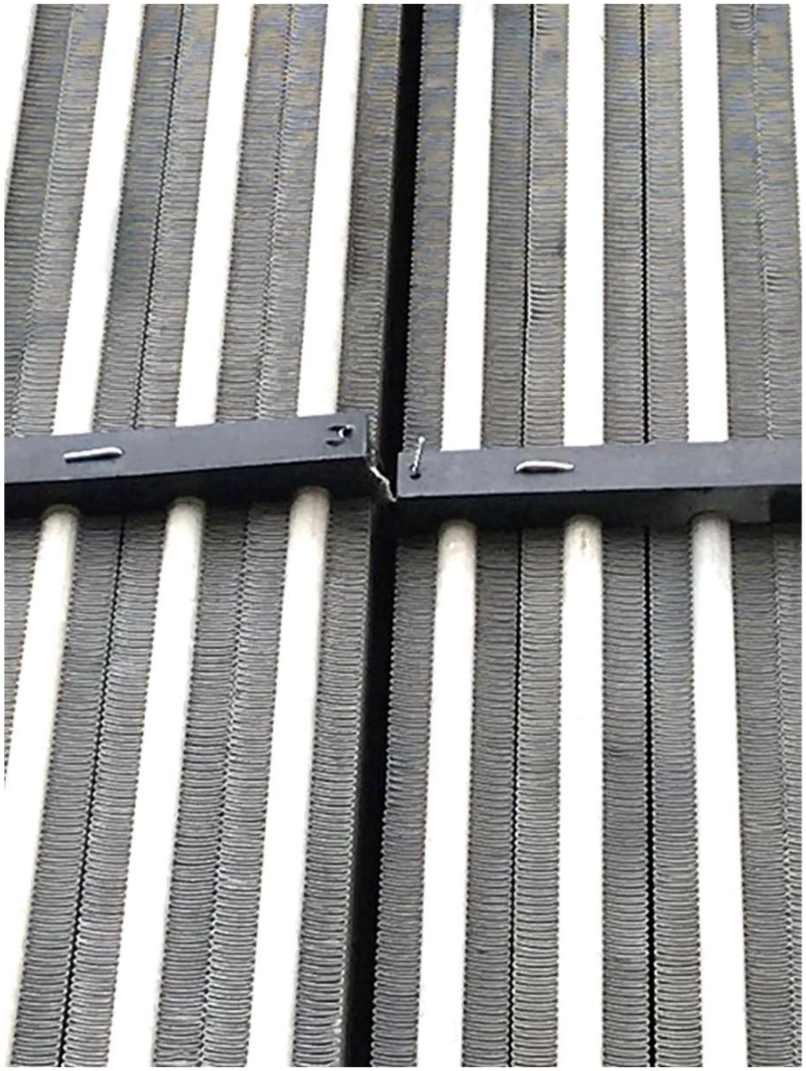
Source: C. Bianchini et al, ACCUG 2016

CFD modeling of wind screen effects on airflow



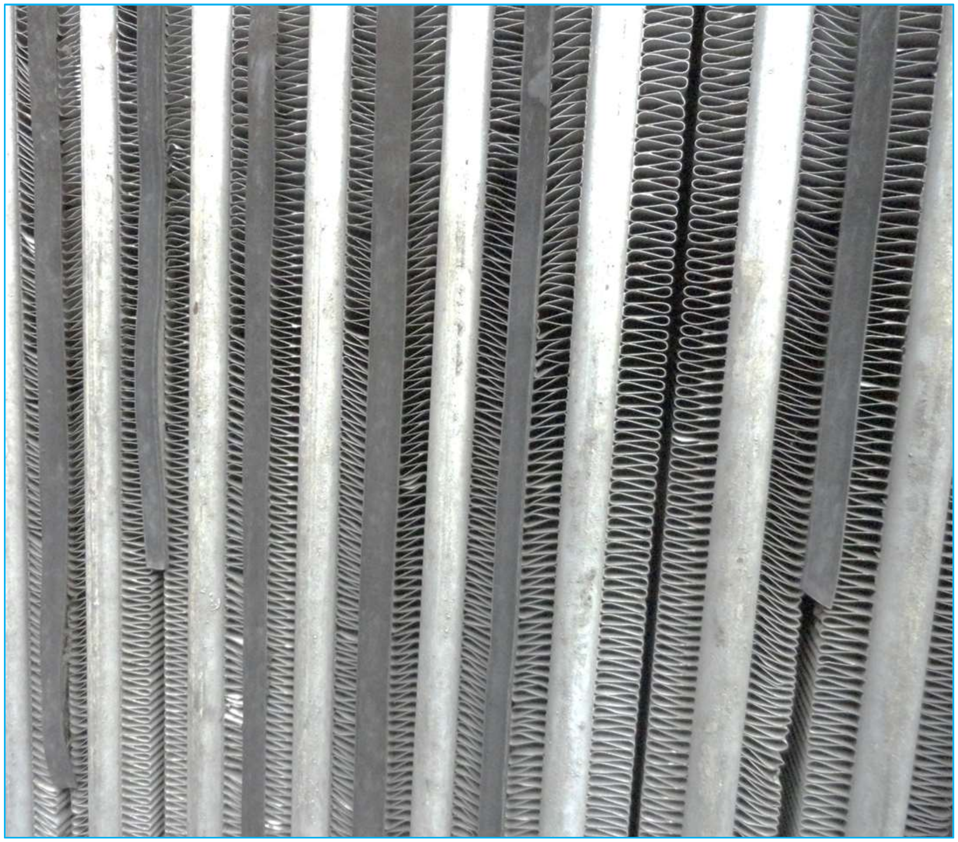
Source: C. Bianchini et al, ACCUG 2016

Gaps / Cooling air bypass



Gaps / Cooling air bypass

Gap repair



Fins bent by hail

Wet Cooling Support

Addition of wet evaporative cooling to direct dry cooling

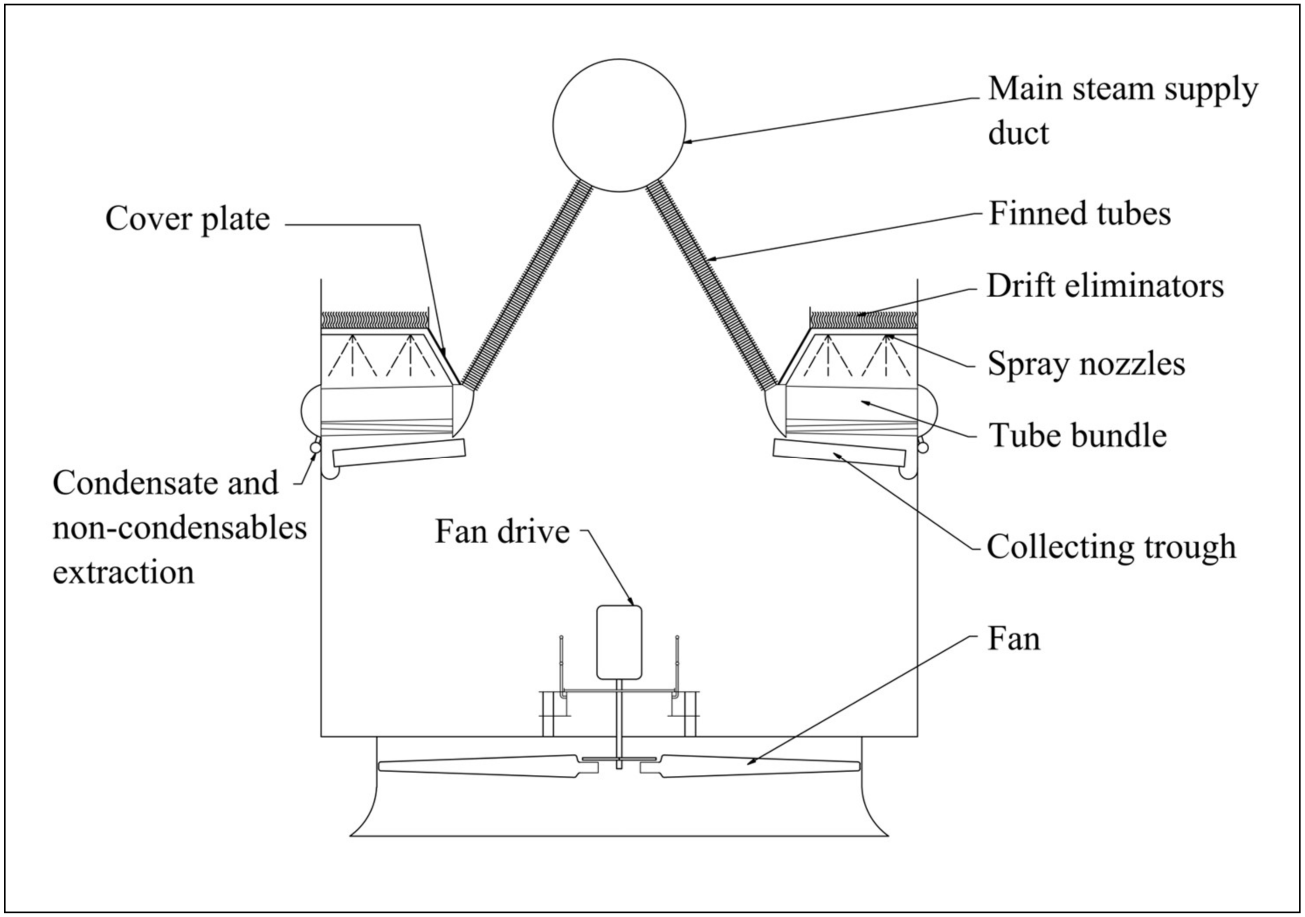
Source: ACCUG 2014 presentation

ACC spray misting

ACC spray misting

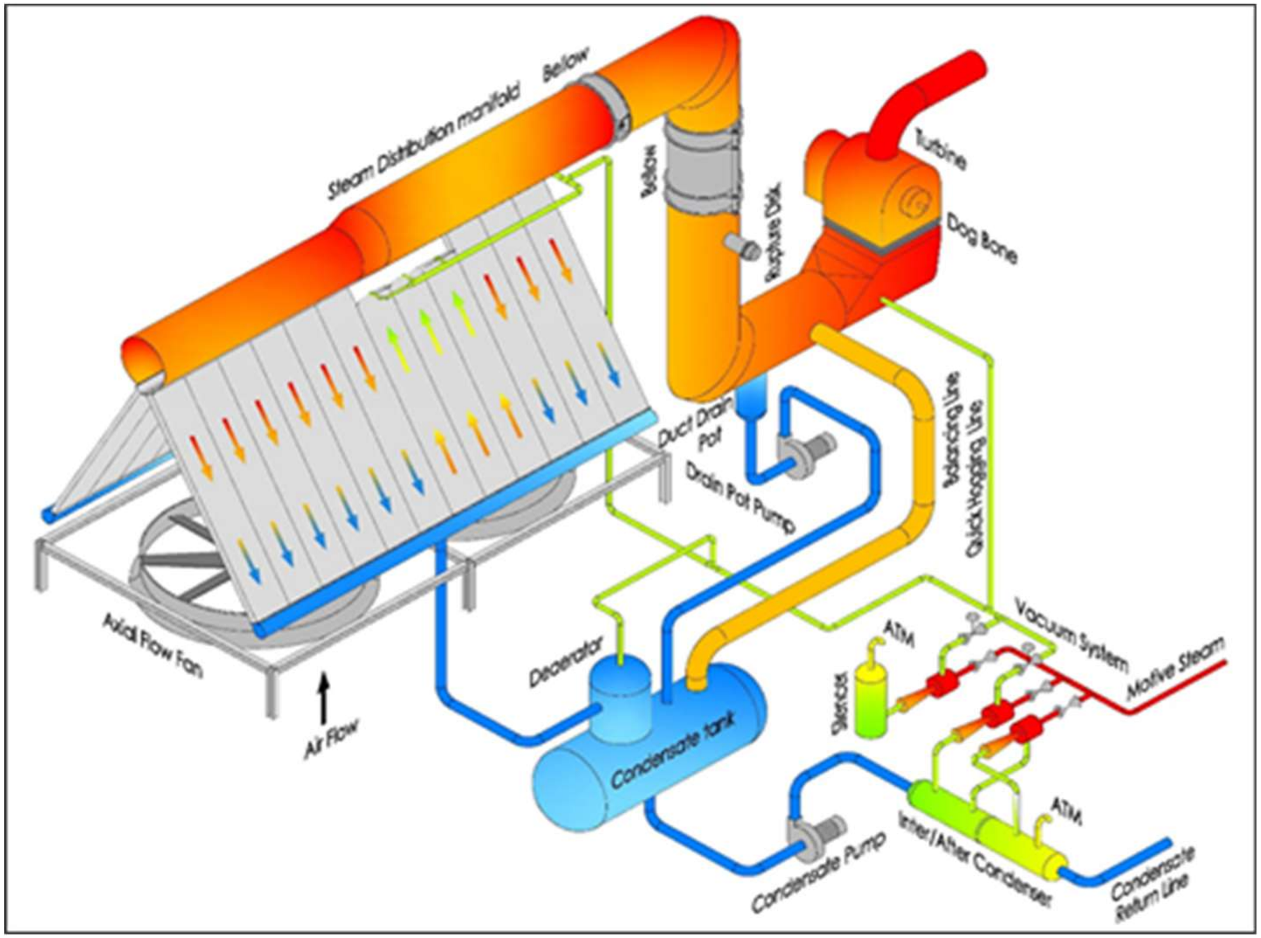
ACC spray misting

ACC deluge cooling



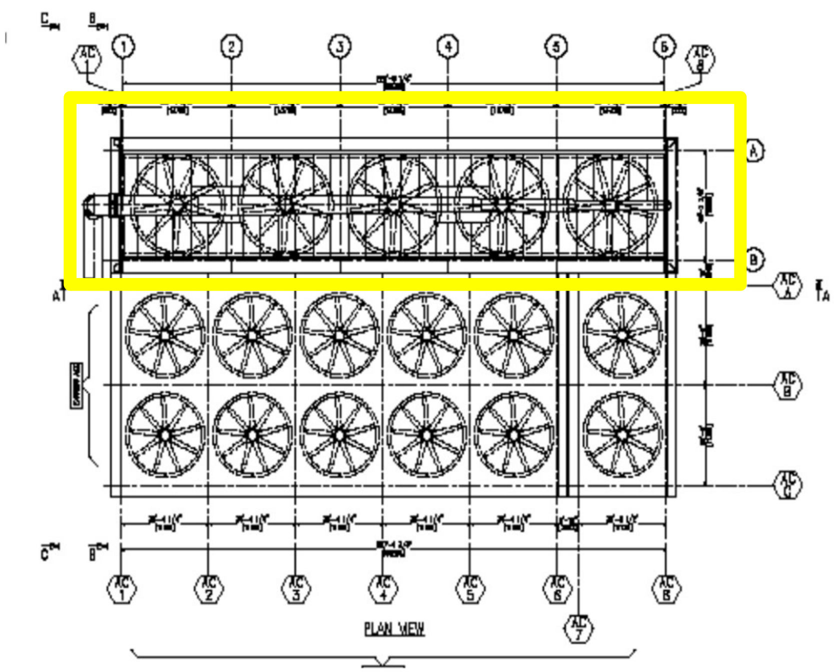
Source: H. Reuter and D. Kroger, Stellenbosch University

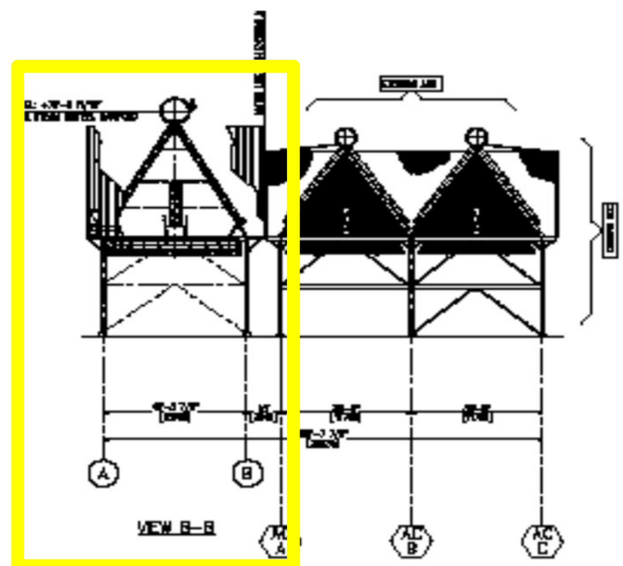
ACC diagram



Source: https://www.evapco-blct.com/dry-cooling-101

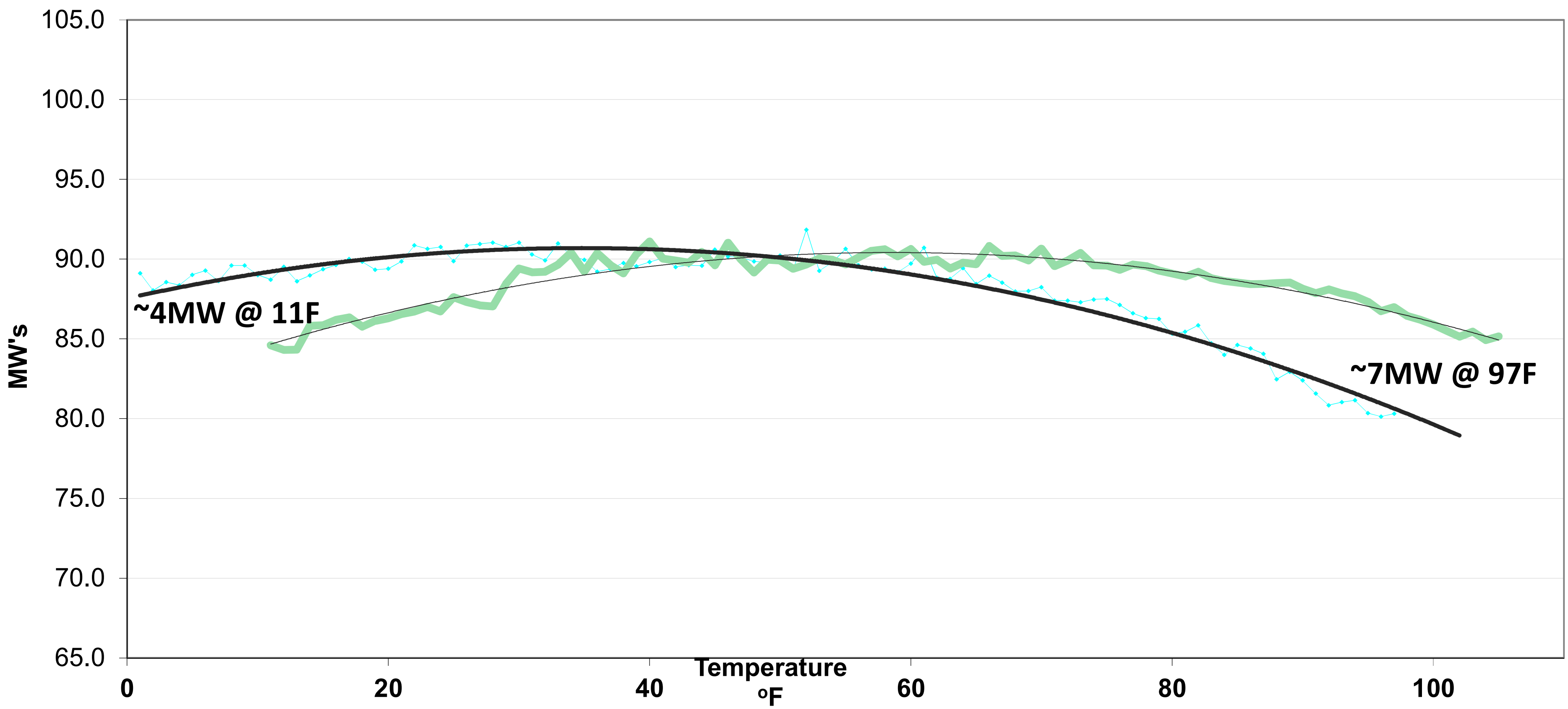
Other retrofit options: ACC expansion





Source: http://acc-usersgroup.org/wp-content/uploads/2012/11/03-Black-Hills-Power-ACCs.pdf

ACC expansion results



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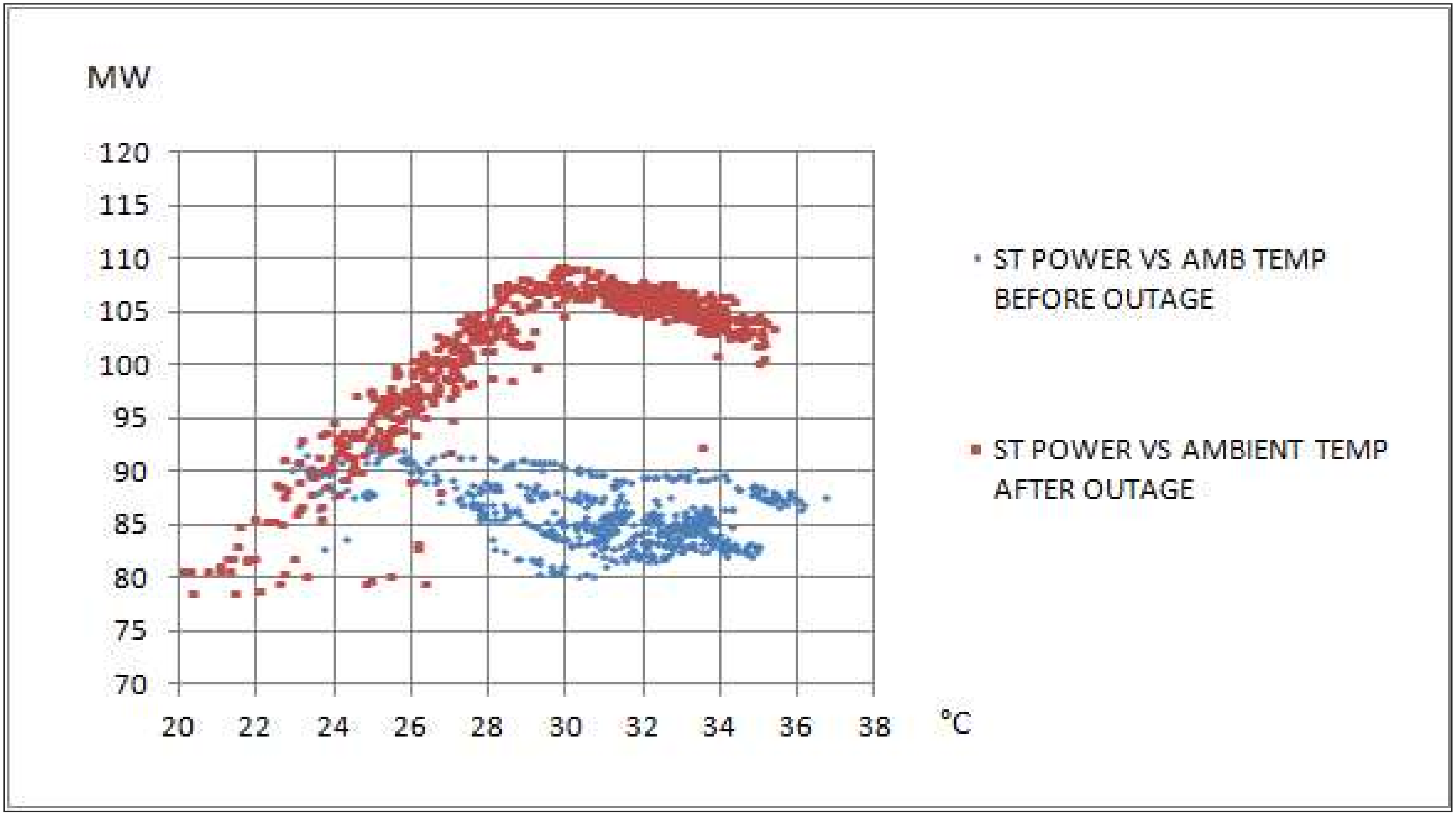
Fan Uprate



Source: ACCUG 2014 presentation

Fan uprate results

- Auxiliaries consumption increase by about 1.12 MW's due to larger fan drive system.
- Complete elimination of the backpressure limitation, with a significant and sustained improvement of at least 120 mBar (3.5 inHg).
- Power output increase due to condenser pressure reduction and now the possibility of increasing condenser load, thus steam flow through the turbine and more power.
- Heat rate improvement due to lower condenser pressure and thus lower backpressure on the steam turbine (more "free" power).

Source: ACCUG 2014 presentation

Conclusions

- Air-cooled condensers are subject to significant operating inefficiencies
- A variety of performance improvements are available and should be evaluated for cost-effectiveness

Design & Performance Discussion

- Users: is your ACC performance acceptable? What would be the value of improving it?
- Does your plant track performance? Is there an initiative to identify performance improvement?