GEA Heat Exchangers

Xcel Energy / ACC Users Meeting

Retrofit of an Air-Cooled Condenser (ACC) to an Existing Water-Cooled Condensing System

September 28 - 29, 2010

GEA Heat Exchangers / GEA Power Cooling, Inc.

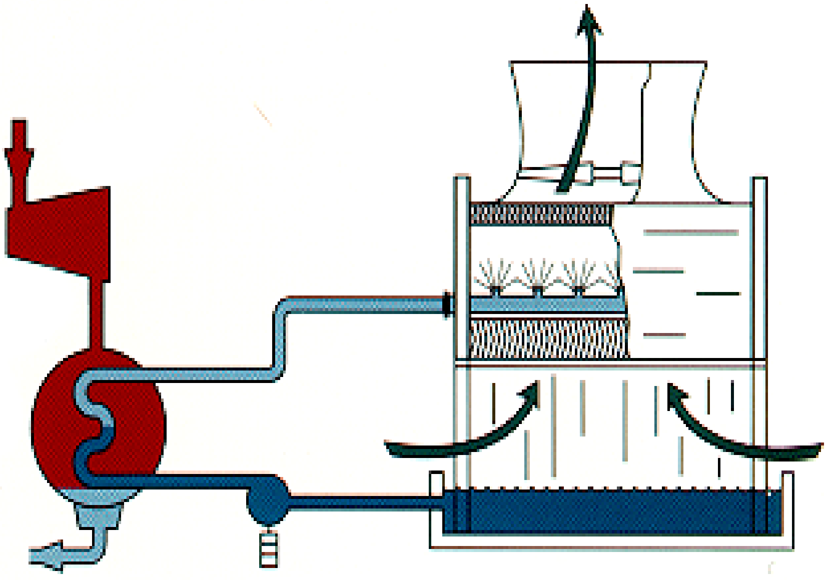
Presentation Outline

- Intro – ACC / WCC / Wet-Dry Systems
- Addition of ACC to WCC – Requirements & Examples
- Addition of ACC to WCC – Performance Benefits
- Other Dry Cooling Alternatives
- Conclusions

Water-Cooled Condensing Systems

- Indirect Heat Rejection
- Multi-component Systems
- Efficient Evaporative Cooling
- Low Capital Cost
- MDT Cell Dimensions:
  - 54’ x 54’
- System ITD: ~40 F
  - Tsat - WBT

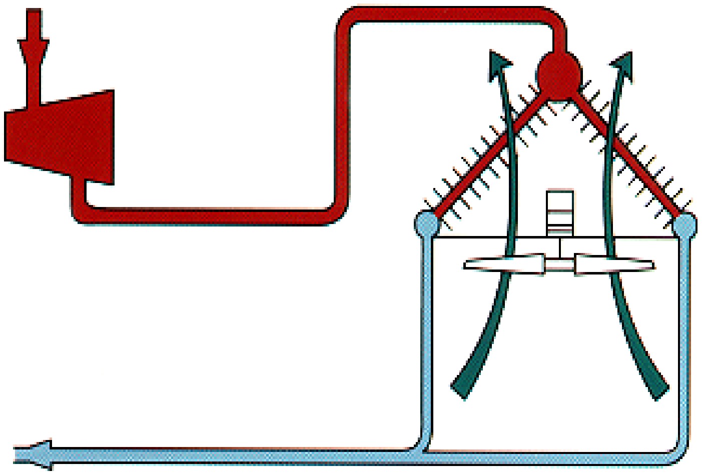
WET COOLING SYSTEM



Air-Cooled Condensing Systems

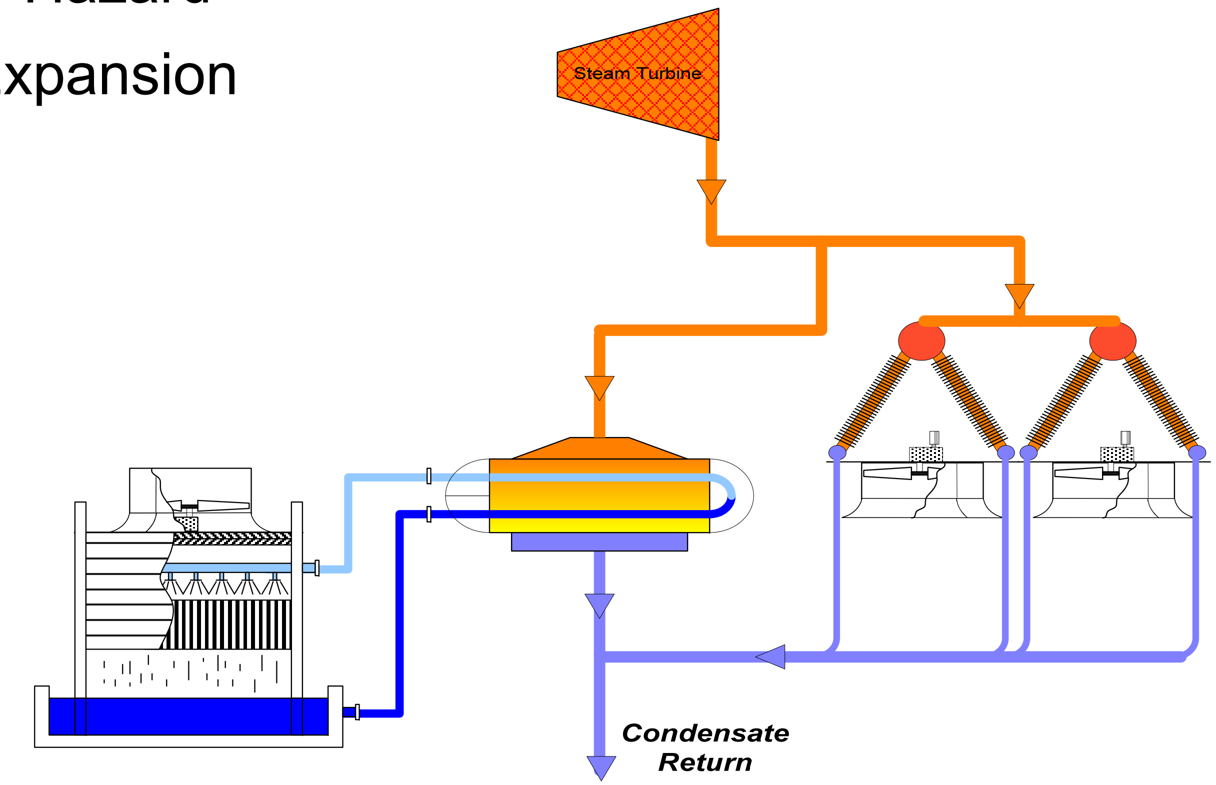
- Direct Condensing
- Complete System
- Higher Capital Cost
- ACC Cell Dimensions:
  - 45’ x 45’ (Nominal)
- System ITD: ~40 F
  - Tsat - DBT

DRY COOLING SYSTEM



Why would you consider an ACC Retrofit?

- Water Scarcity
- Plume Problem / Hazard
- Plant Upgrade/Expansion



ACC Retrofit Requirements

- Access to Steam Turbine Exhaust for Steam Duct Tie-in
- Available Space
- Non-restrictive Height Limitations
- Additional Noise Emission
- Available Capital Investment

ACC Retrofit Requirements – Access to STG

ACC Retrofit Example – Streeter Generating Station

- Addition of Dry Cooling was required to eliminate cooling tower plume in cold ambient conditions to eliminate freezing hazard on newly constructed freeway adjacent to plant
- Available space near turbine hall
- Access to STG exhaust was tight but achievable
- ACC was constructed and tie-in was accomplished during planned outage

ACC Retrofit Example – Streeter Generating Station

ACC Retrofit Example – Tie-in to STG Exhaust

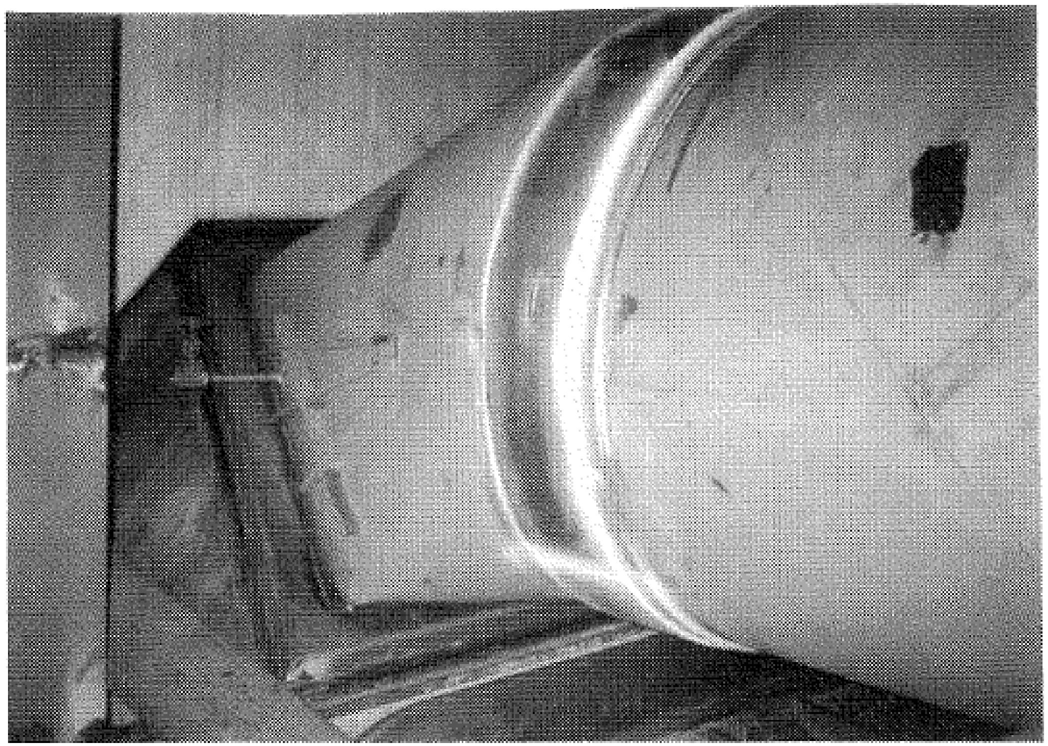


Figure 9

Transition Section Between Surface Condenser

And Steam Duct Riser (Typical of Four)

ACC Retrofit Example – Tie-in to STG Exhaust

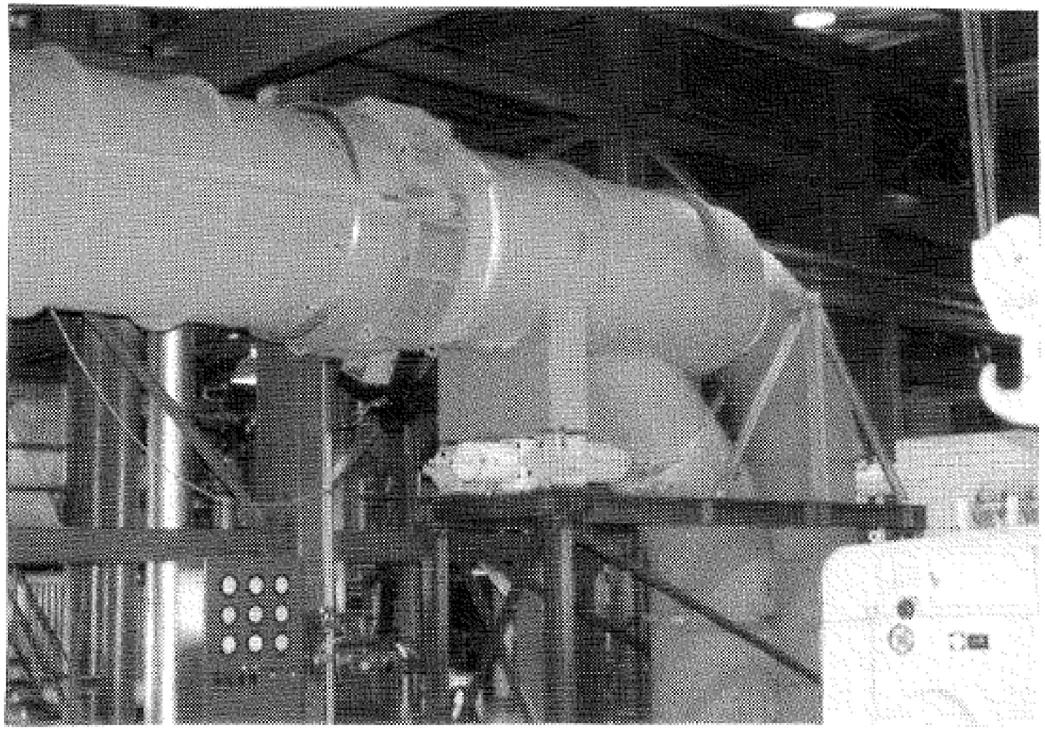


Figure 10

Connection of Twin Risers Into 72" Duct

(Duplicated on Other Side of Condenser)

ACC Retrofit Example – Tie-in to STG Exhaust

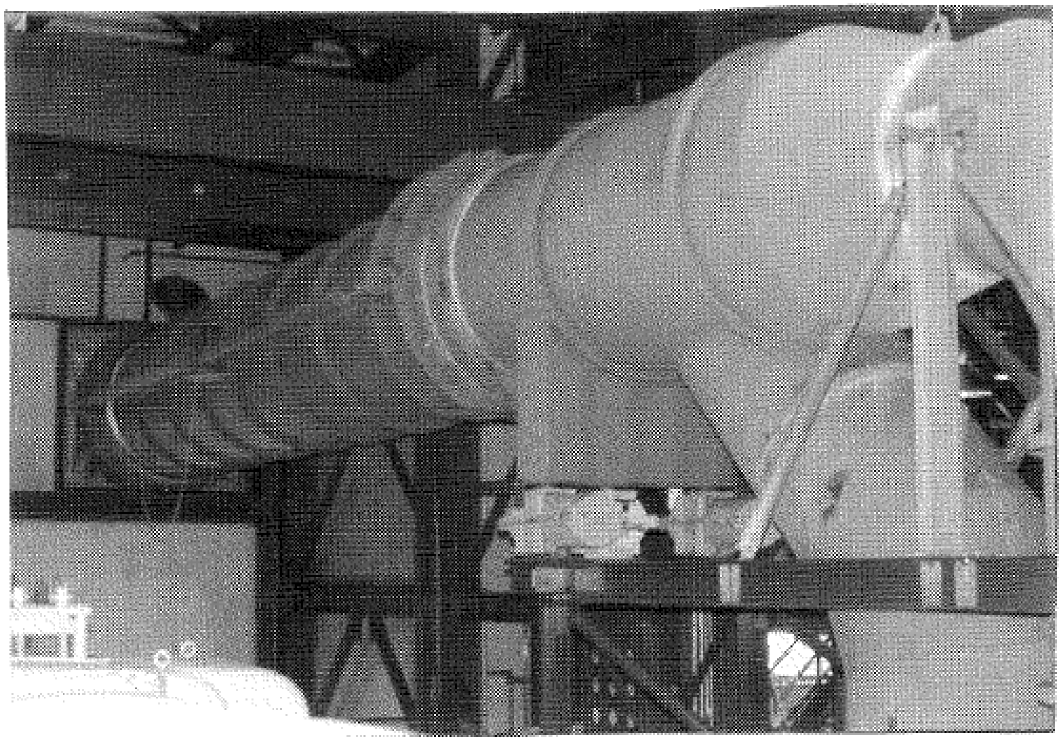


Figure 11

72" Diameter Duct Passing Through Turbine Hall (Duplicated on Other Side of Hall)

ACC Retrofit Example – Tie-in to STG Exhaust

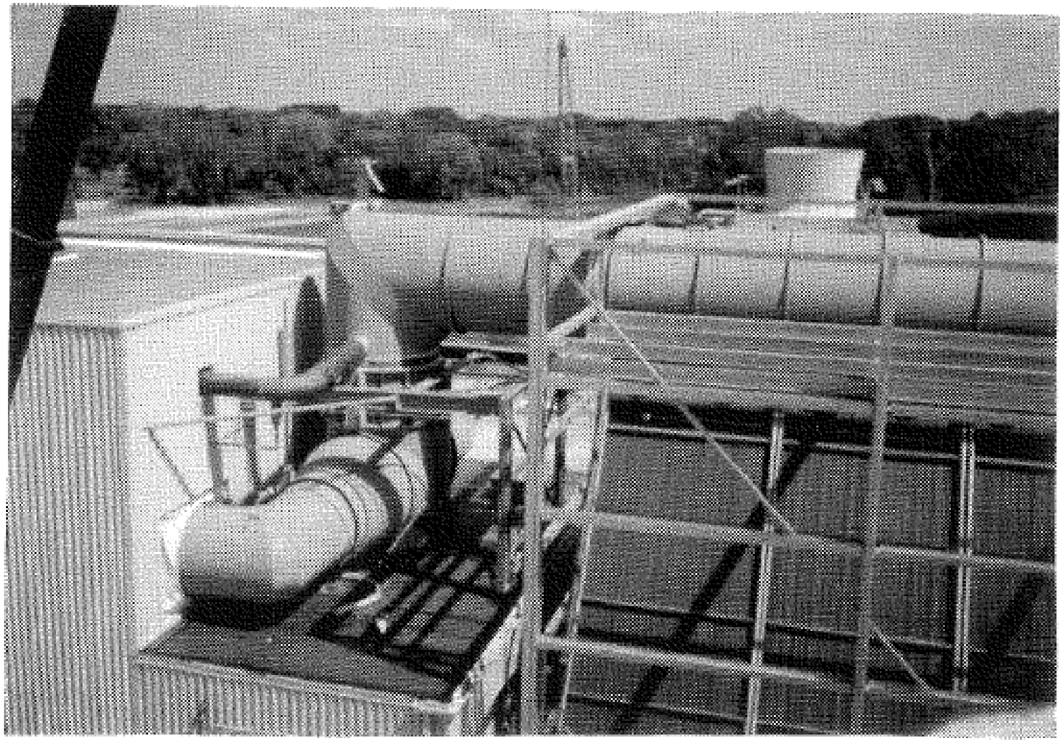


Figure 12

72" Ducts Emerging Out of Turbine Building

And Joining Up With Main 102" Duct

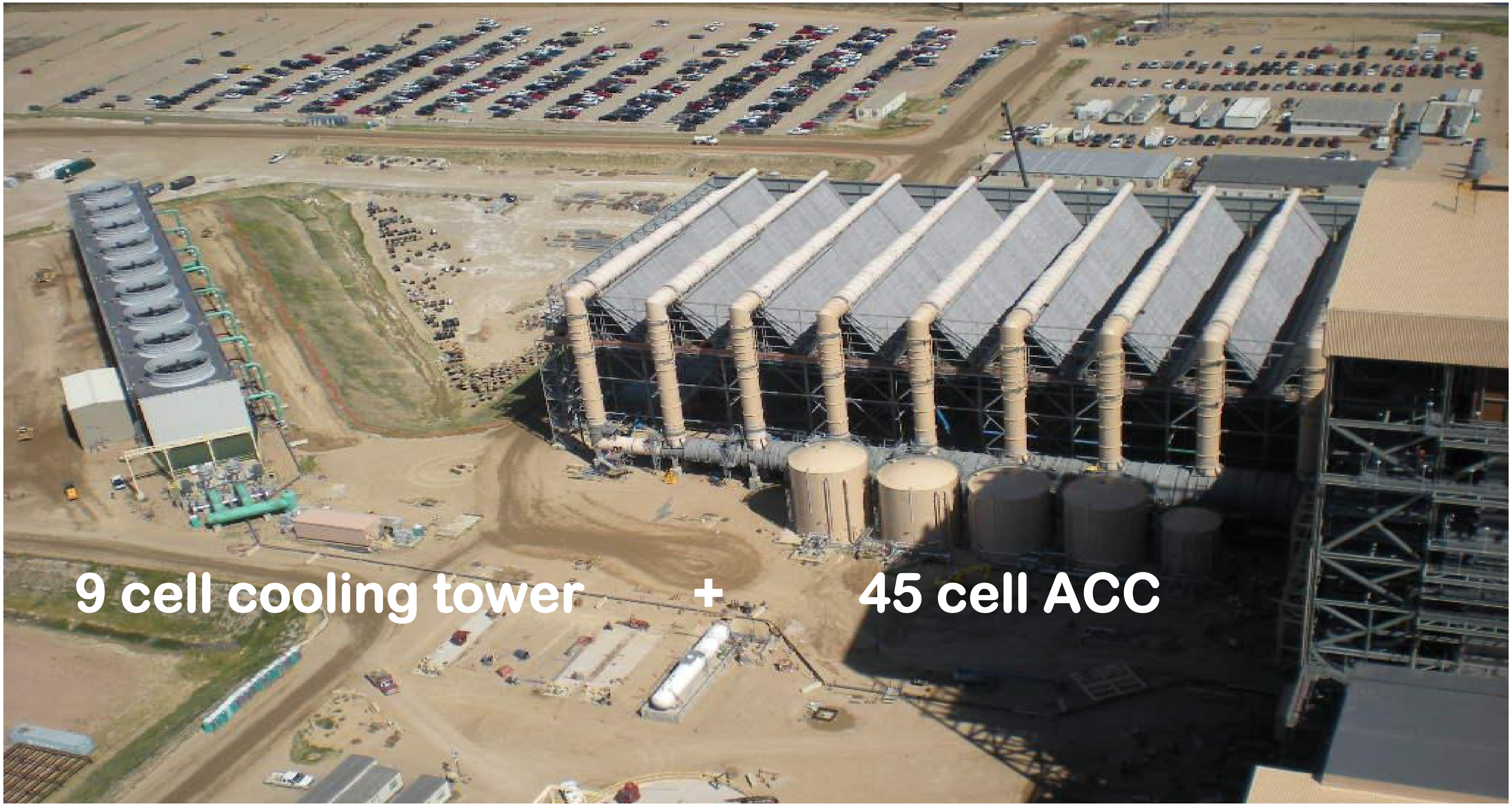
ACC Retrofit to WCC – Performance Benefits

Example (Comanche 3)

- Location: Pueblo, Colorado
- Owner: Xcel Energy
- Plant type: Coal – Fired
- Output: 750 Mwe
- Heat rejection system water limit: $4x10^6$ m³/yr
- GEA Scope:
  - ACC (material supply)
  - MDCT (material supply & erection)
  - SSC (material supply)

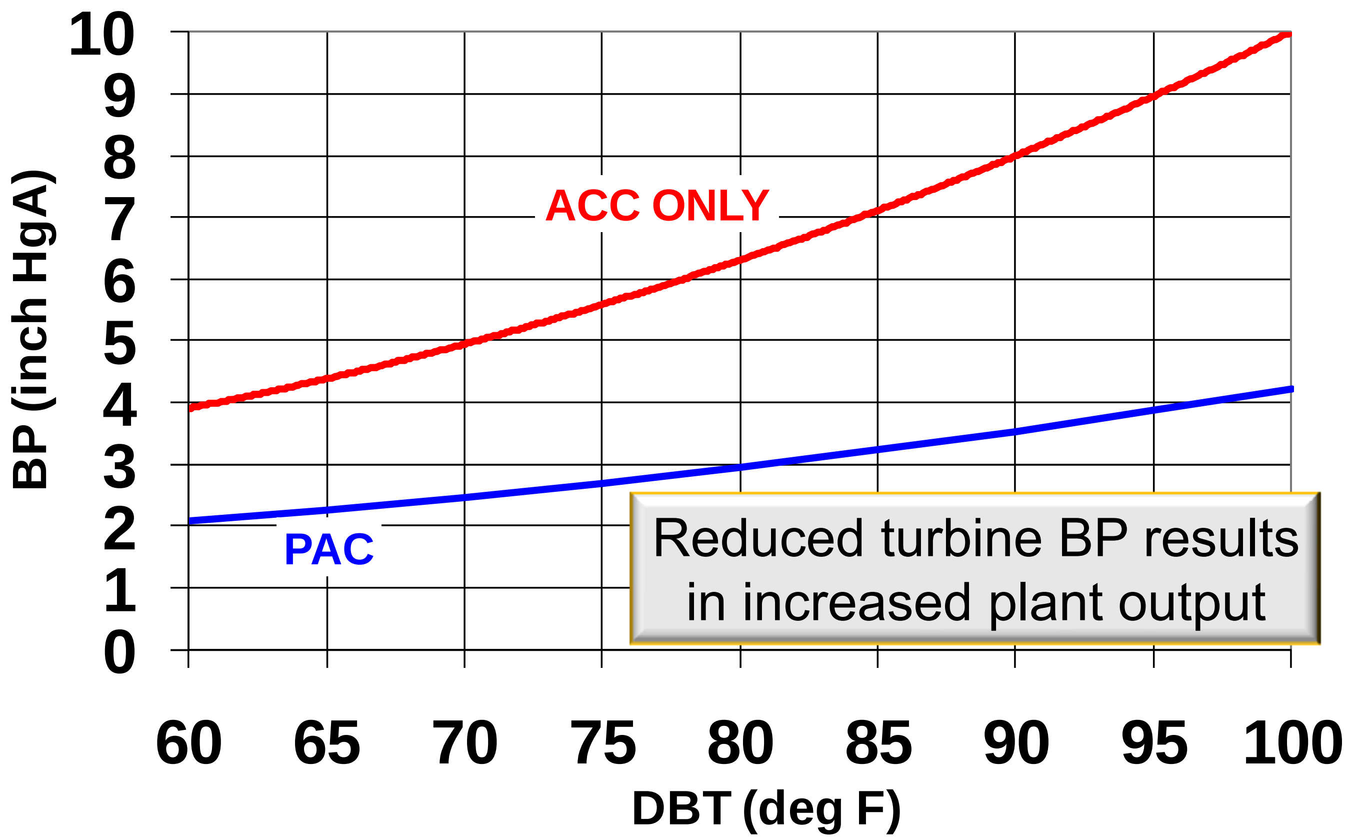
ACC Retrofit to WCC – Performance Benefits

Example (Comanche 3)



ACC Retrofit to WCC – Performance Benefits

Example (Comanche 3): reduced BP in summer with PAC



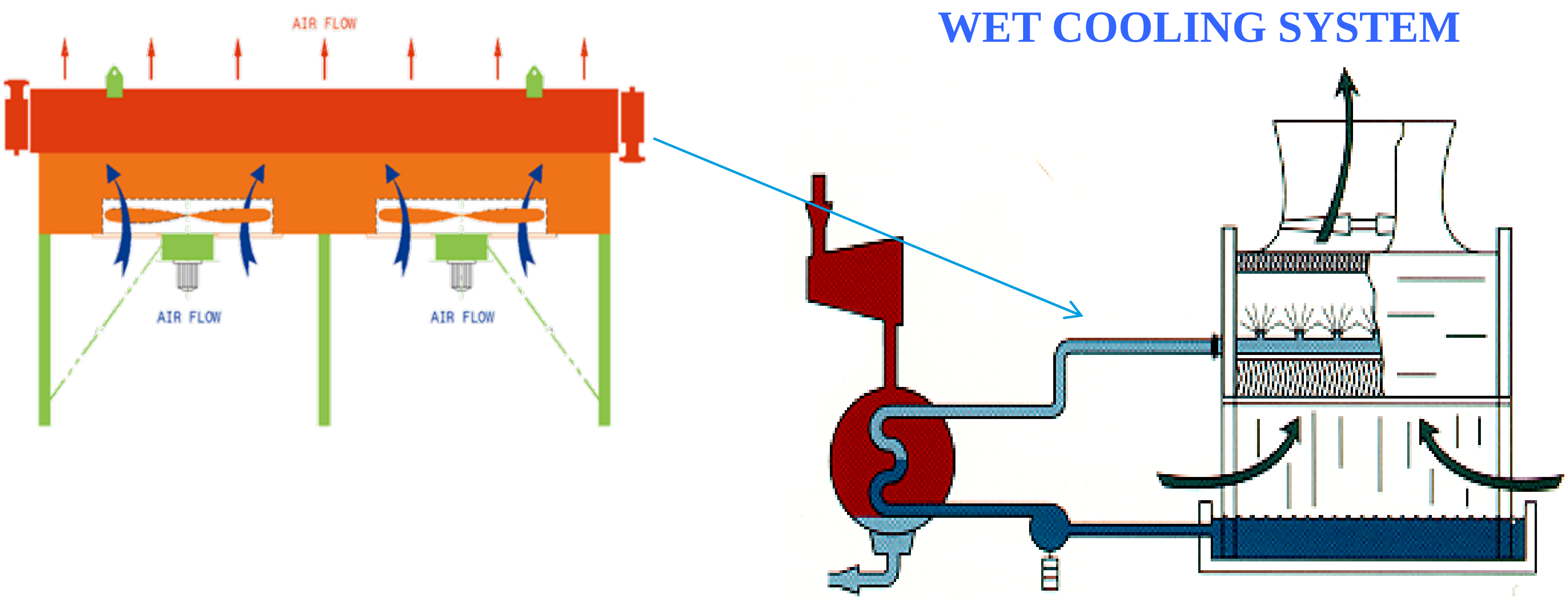
Additional Considerations:

- Existing steam turbine backpressure limits
- Contribution of ACC during high ambient temperatures may be limited
- Majority of water conservation will take place in lower ambient temperatures
- Water storage capabilities may be required to maximize use of water in summer months
- Integration of auxiliary systems (air removal, condensate collection, etc.)

ACC Retrofit to WCC – Other Options

Dry Cooling Retrofit – Series Wet/Dry Cooling

- Addition of Air-Cooled Heat Exchanger to circulating water circuit

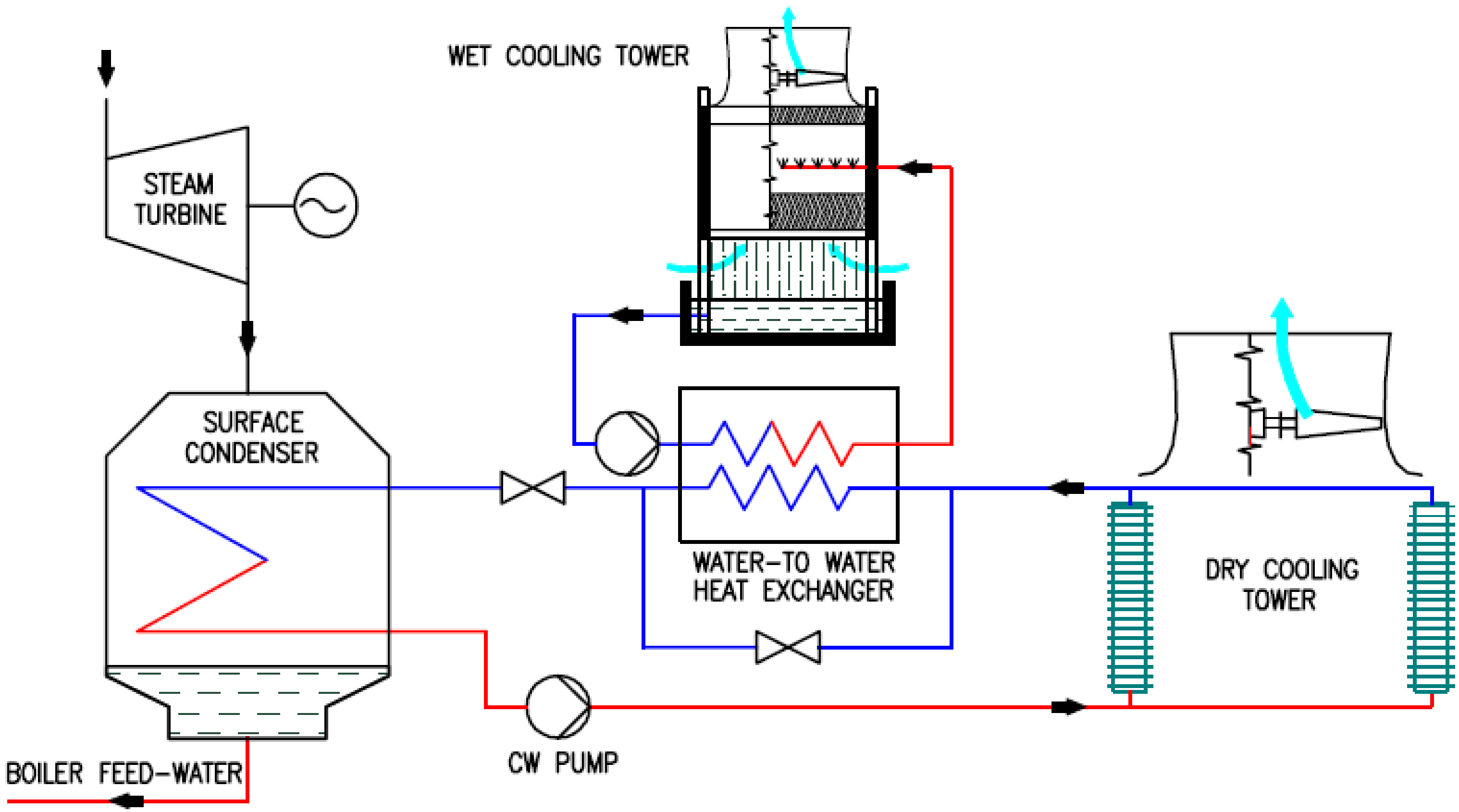


Dry Cooling Retrofit – Series Wet/Dry Cooling

- Advantages:
  - ACHE can be placed anywhere on site where space is available
  - No modifications required to STG exhaust or existing surface condenser
- Disadvantages:
  - Increased surface area relative to direct ACC due to TTD across surface condenser
  - Expensive tube materials required for open-circuit cooling water
  - ACHE can require large space and high cost if dry heat rejection requirements are substantial

Dry Cooling Retrofit – Parallel Wet/Dry Cooling

- Addition of Water to Water HX and Dry Cooling Tower



Dry Cooling Retrofit – Parallel Wet/Dry Cooling

- Advantages:
  - Dry tower can use standard tube materials based on closed circuit cooling
  - Dry tower can be placed anywhere on site where space is available
  - No modifications required to STG exhaust or existing surface condenser
- Disadvantages:
  - Increased surface area relative to direct ACC due to TTD across surface condenser
  - Modification required to existing circulating water system to include water-to-water HX

ACC Retrofit to WCC – Conclusions

Solutions of adding dry cooling to existing WCC Plants using proven technologies are available

Project Specific Considerations:

- Direct condensing (ACC) should be considered first for substantial heat rejection needs due to best economy (largest available ITD will result in lowest relative surface area required) and minimum plot area requirements
- Significant obstacles may make an ACC Retrofit prohibitive
- Various other solutions can be employed based on plant specific criteria
- A detailed analysis of all dry cooling retrofit options may be required

Q&A

Questions and Answers

GEA Power Cooling, Inc.
143 Union Blvd., Suite 400 ■ Lakewood, CO 80228
(303) 987-0123 www.geapowercooling.com