AIR COOLED CONDENSER
USERS GROUP

ACC Industry Status and Developments

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International Air-Cooled Condenser Meeting

October 13-15, 2015 • Xi’an, China

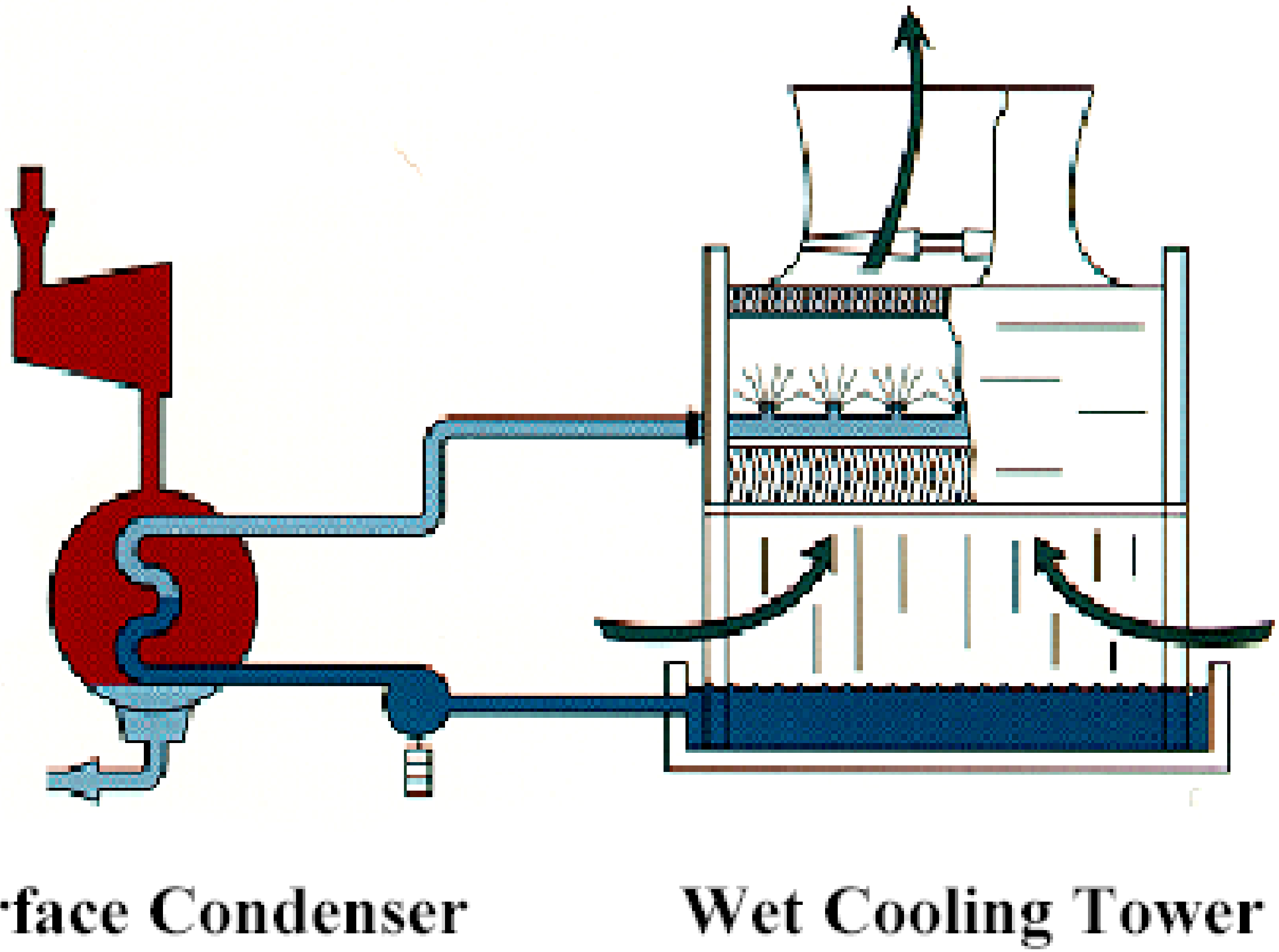
Air-Cooled Condenser Users Group

ACCUG – established 2009

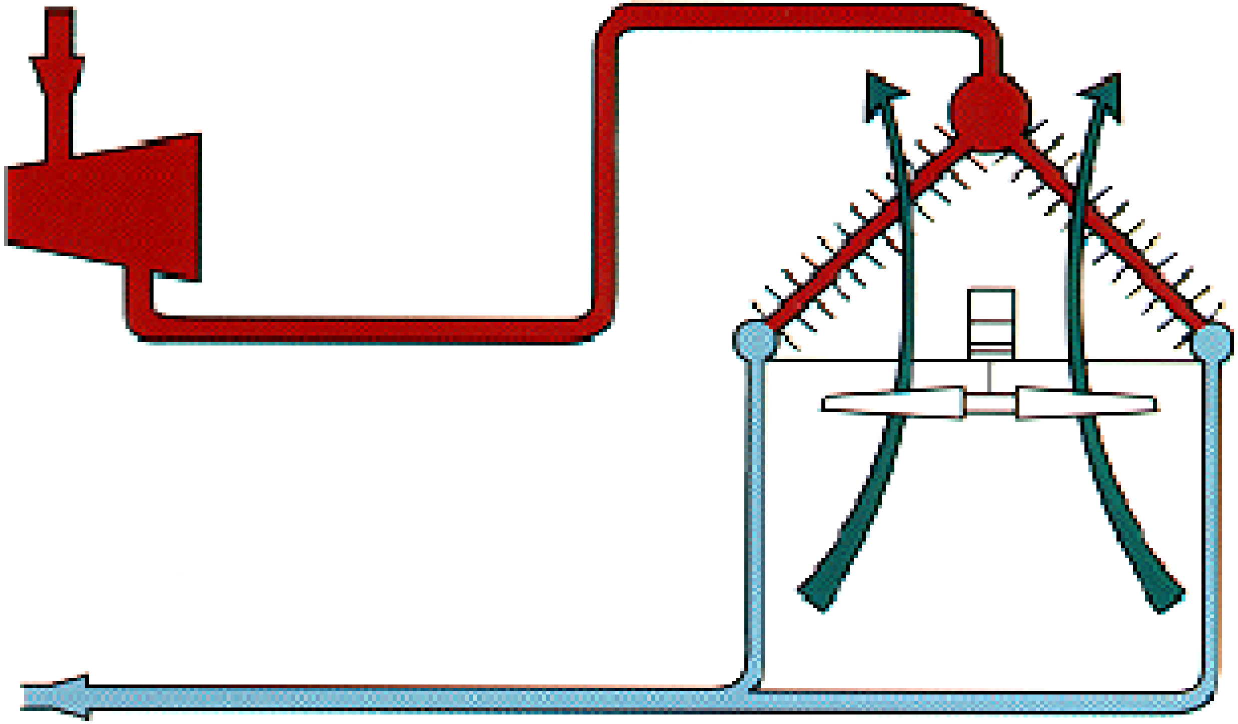
Website: http://acc-usersgroup.org/

Look under "Presentations" tab for presentations from the first 7 years of meetings.

Evaporative (Wet) Cooling Tower



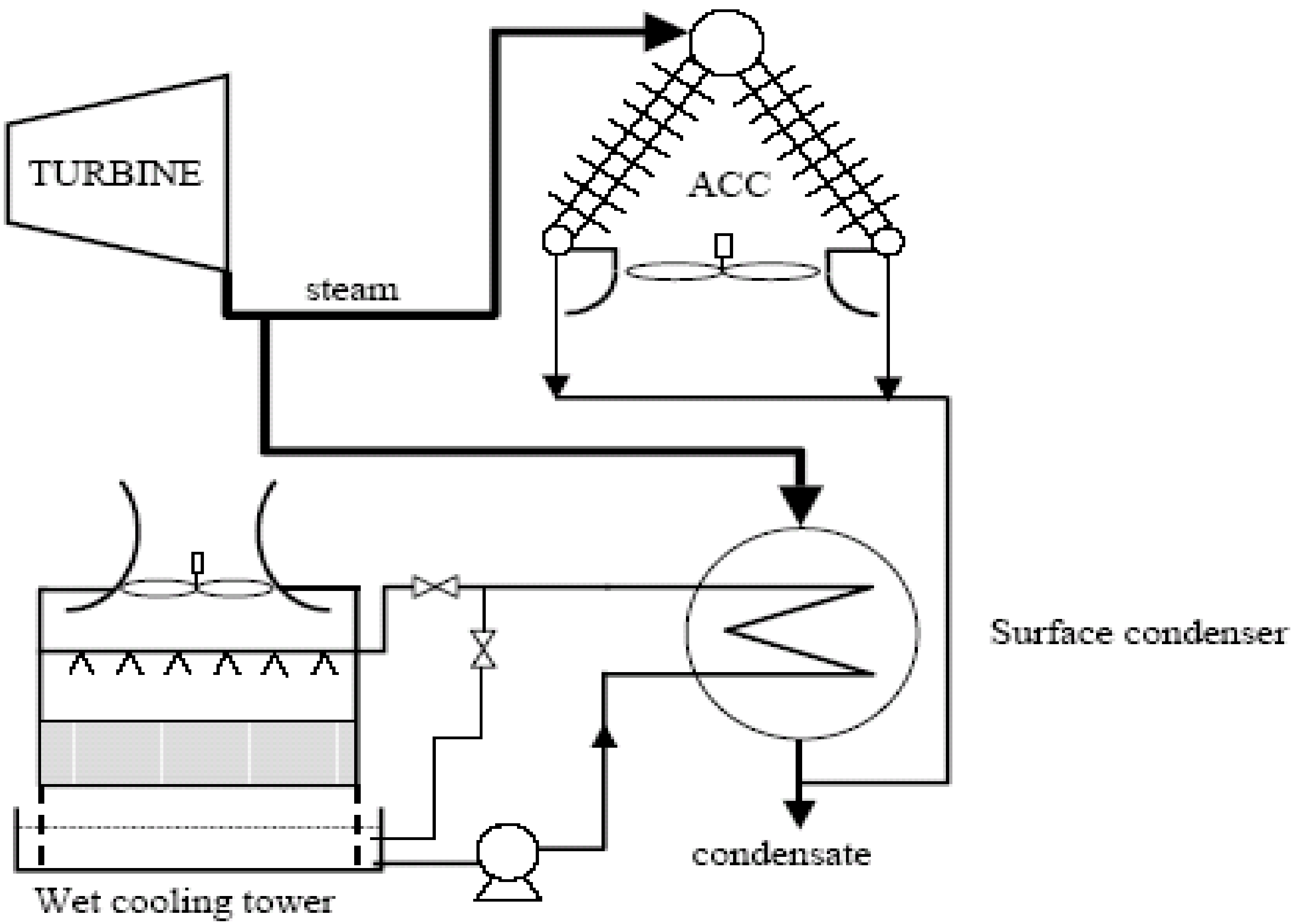
Dry (Air) Cooling



Air Cooled Condenser

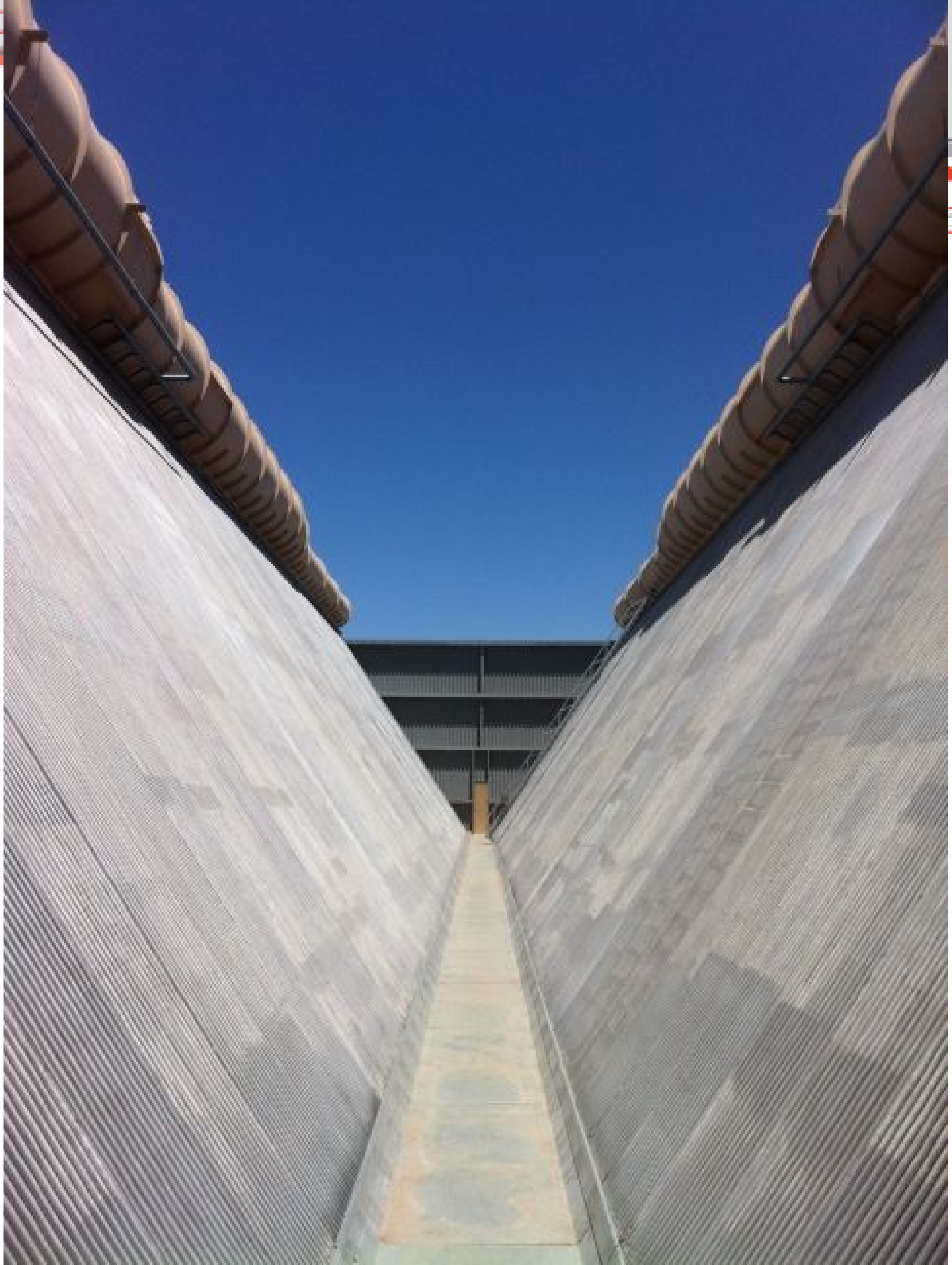
GEA

Parallel Cooling



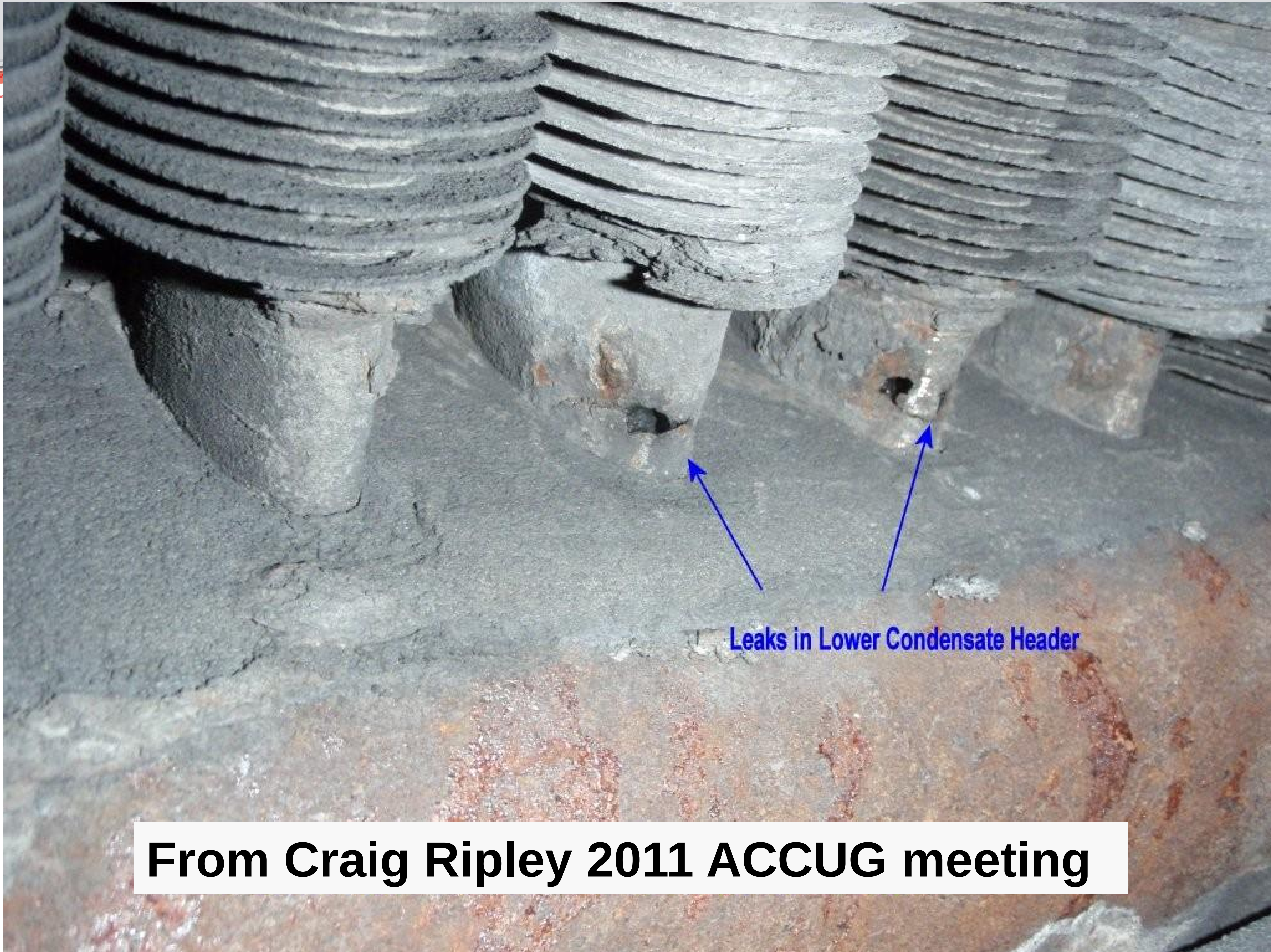
Air Cooled Condenser: Under Construction

Main Turbine Exhaust Duct: 35’ (11 m) diameter



Typical Large Air-Cooled Condenser

- 45 fans, drawing ~8 MW combined
- 9 ‘streets’ or bays, 20,358 tubes total
- tubes:
  - single-row
  - 35.3 feet (10.8 m) length
  - 8.2 by 0.75 inch (21 by 2 cm) cross-section
  - carbon steel with aluminum exterior fins
  - 0.059 inch (1.5 mm) wall thickness
  - 1,158,902 ft^2 internal (107,000 m^2)
  - 16,514,080 ft^2 external (1,500,000 m^2)



From Craig Ripley 2011 ACCUG meeting

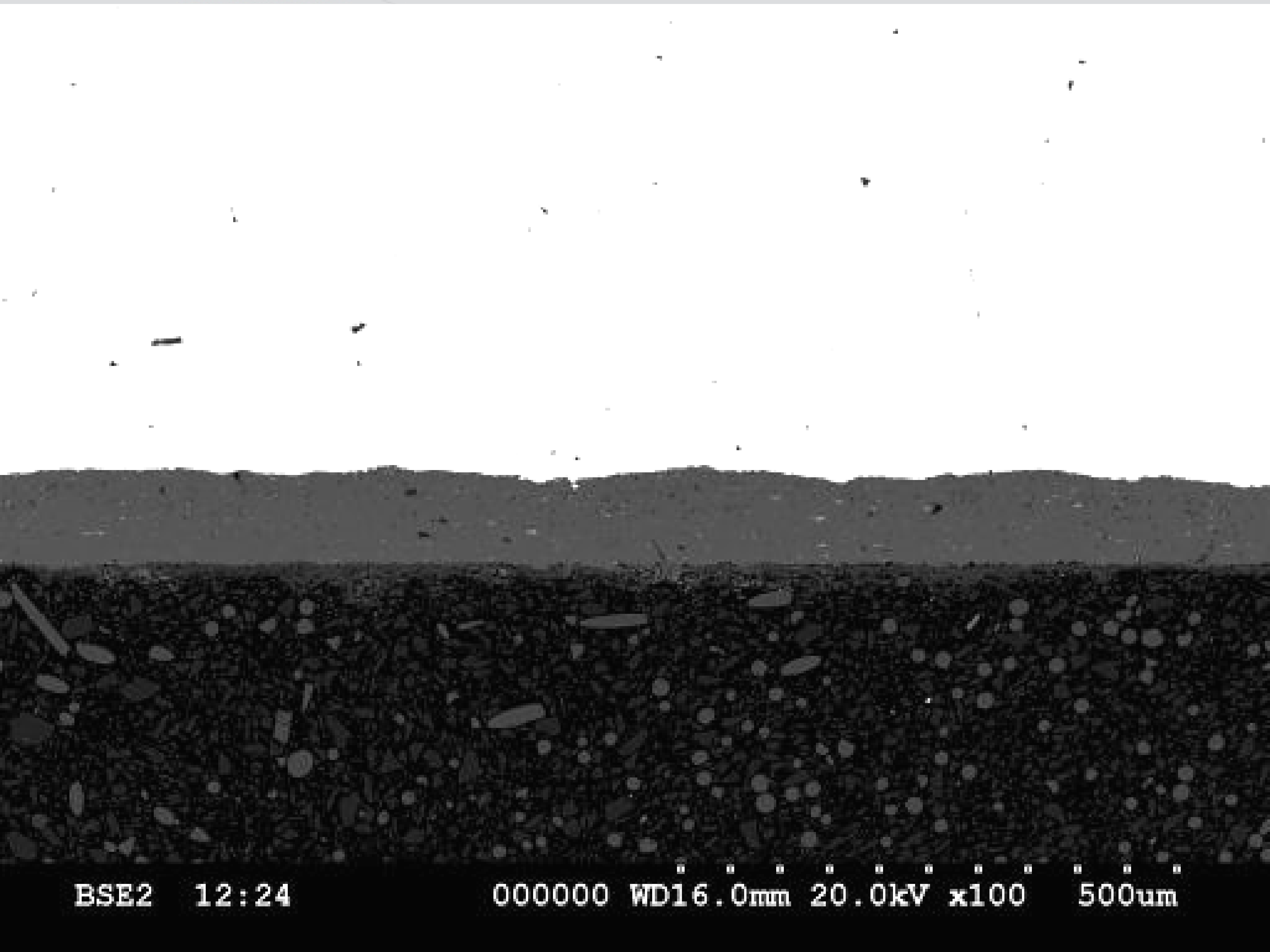

FEB 8 2007

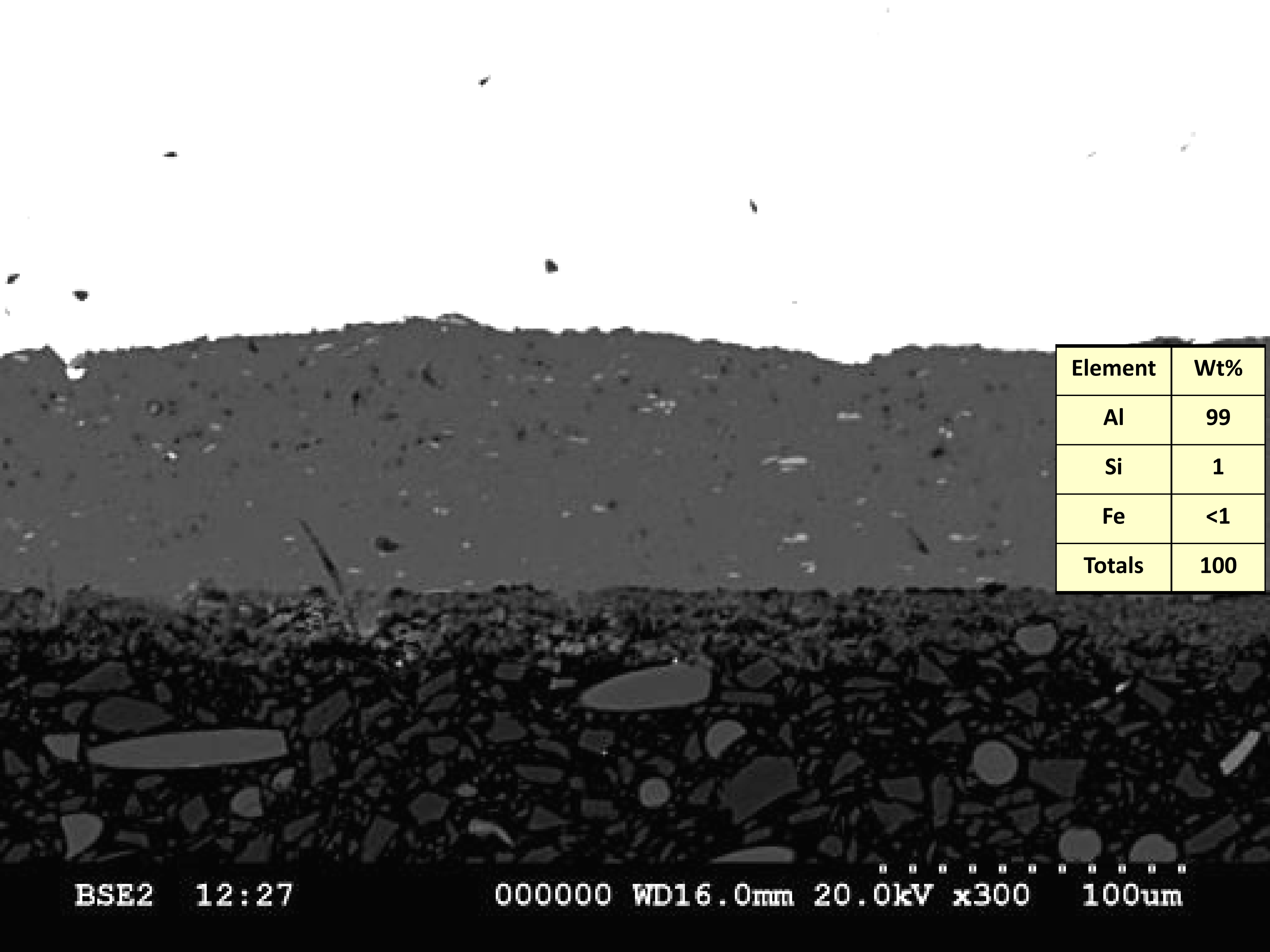



Coating process options

Note: only high-pressure cladding and molten aluminum dipping are believed to have been used for Al coating of ACC tubes at this point.

- **High pressure cladding**
  - **costly process although costs have lowered**
  - **strong steel-to-aluminum bond**


BSE2 12:24
000000 WD16.0mm 20.0kV x100 500um



Element	Wt%
Al	99
Si	1
Fe	<1
Totals	100

Coating process options

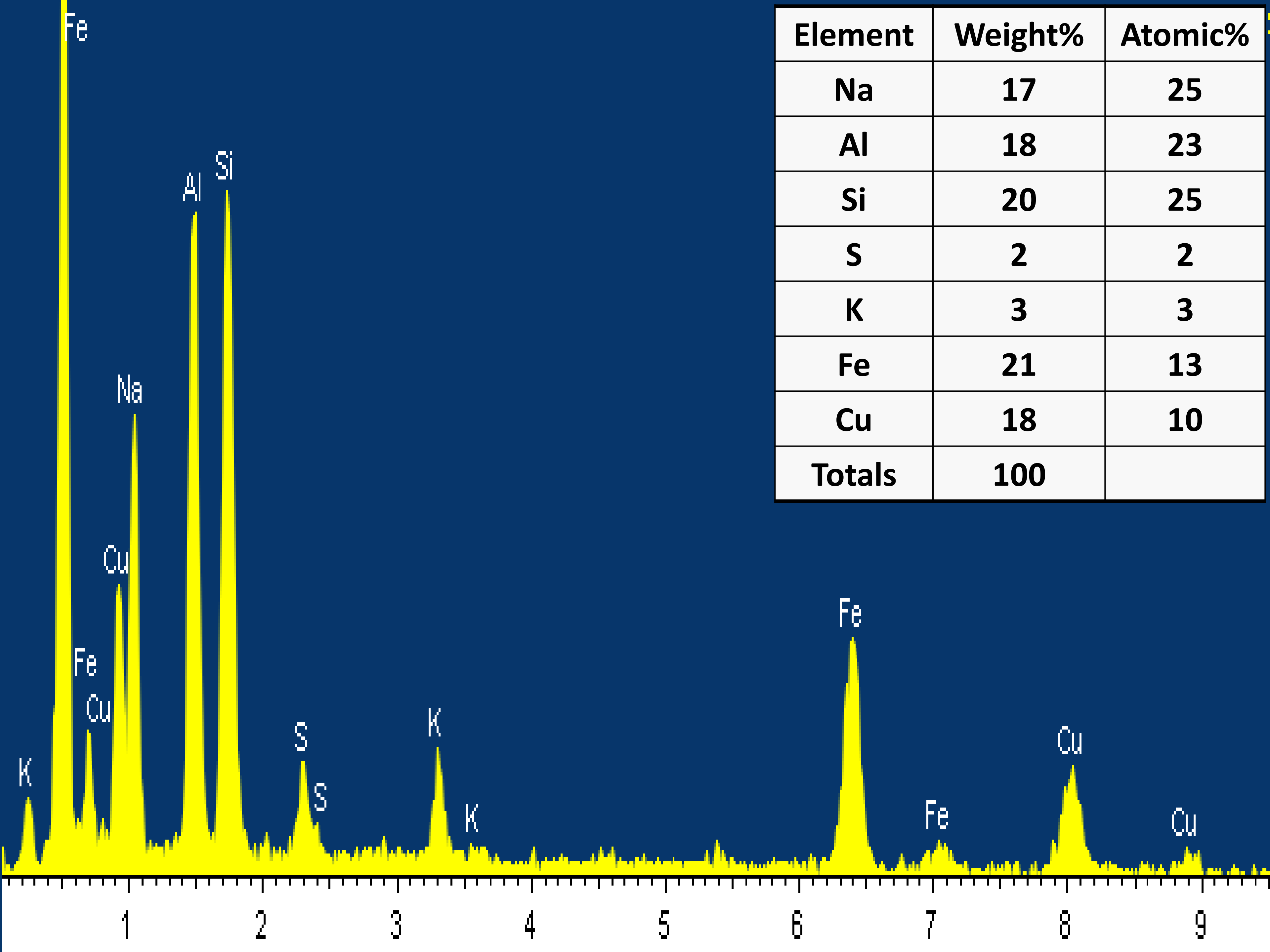
- **Dipping tubes in molten aluminum**
  - lower cost
  - lower thickness
  - uniformity and durability of coating uncertain

Coating processes

- Influence of manufacturing process on internal tube Al contamination is uncertain
  - dipped tubes risk internal Al if not enclosed adequately (parallel with known problem for Zn-coated tubes)
  - brazing temperature is too low for Al volatilization

Concerns regarding Al coating

- **Possible ingress of Al to tube interior during manufacture**
  - **deposition on HP section of steam turbine and loss of turbine performance**
  - **limited options for removal of Al deposits from HP turbine other than turbine outage (7 to 10-year cycle)**



Element	Weight%	Atomic%
Na	17	25
Al	18	23
Si	20	25
S	2	2
K	3	3
Fe	21	13
Cu	18	10
Totals	100	

Improper Galvanic Tube Coating

Air Cooled Condenser Design

- Last major design change in direct-cooled ACCs was in 1991: single-row finned tubes
- Changes since that time have been relative minor:
  - tube coating / fin spacing
  - investigating electric vs geared fan power
  - wind considerations – shields, siting etc.
  - fan blade material / variable speed motors
  - fast starting capability
  - control & freeze protection strategies
  - construction efficiency to lower labor cost
  - enhanced controls
  - performance improvement with available water

Air Cooled Condenser Design

- Indirect-cooled ACCs have not seen widespread use worldwide, but have some favorable characteristics
  - lower energy requirements
  - easier to design limited water cooling support
  - uncertainties about materials (aluminum heat exchange tubing)
  - can be retrofitted to an existing wet-cooled plant much easier than with a direct-cooled ACC

Air Cooling Alternatives

- Research is ongoing into various alternative dry cooling technologies, but none has reached full-scale implementation at this point
- Electric Power Research Institute, U.S. National Science Foundation, U.S. Department of Energy, European Union projects

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.

Air Cooled Condenser Applications

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  - Australia
  - Western United States
  - China
- Recent installations in areas with plenty of water, due to environmental regulations limiting water use.
- Concentrated solar plants often use dry cooling
- Hybrid (wet-dry) cooling is an important option where adequate water is available.

Distribution of Air-Cooled Condensers for Power Generation: North America

- USA – more than 100, most direct-cooled combined cycle plants, some coal and solar, a few parallel wet-dry cooled units
- Mexico – growing number of direct-cooled combined cycle plants
- Canada – a few combined cycle plants

Distribution of Air-Cooled Condensers for Power Generation: North America

- Estimated that 20-40% of new plants in North America will be dry-cooled, a steady to increasing trend
- Lack of access to water is promoting ACCs even where plenty of water is present, including difficulty getting water use permits
- Increasing interest in hybrid cooling, including retrofit, although few have been installed at this point

Distribution of Air-Cooled Condensers for Power Generation: Central / South America

- **ACC units in Peru, Venezuela, Argentina, Brazil, Trinidad & Tobago – direct-cooled, combined cycle plants**

Distribution of Air-Cooled Condensers for Power Generation: Europe

- ACC units in Ireland, United Kingdom, Spain, Belgium, Luxemburg, Italy, Greece
  - most direct-cooled, limited indirect-cooled

Distribution of Air-Cooled Condensers for Power Generation: Middle-East

- ACC units in Turkey, Israel, Jordan, Saudi Arabia, Qatar, Bahrain
  - most direct-cooled, combined cycle plants

Distribution of Air-Cooled Condensers for Power Generation: Africa

- ACC units in Algeria, Morocco, South Africa, Ivory Coast
  - direct-cooled, limited indirect-cooled; coal and combined cycle units, several solar installations

Distribution of Air-Cooled Condensers for Power Generation: Asia

- Increasing installation of direct-cooled ACCs, including India, Bangladesh, Indonesia, Vietnam, Pakistan, Taiwan, Japan, China, Russia
- China: more than 100 ACCs and increasing rapidly. Many are direct-cooled, more recent emphasis on indirect-cooled due to power savings; virtually all are on coal-fired units.

Distribution of Air-Cooled Condensers for Power Generation: China

- **~ 1,430 GW of total power generation: ~10% use ACCs, approaching half of thermal power generation in rapidly-growing sector**

Distribution of Air-Cooled Condensers for Power Generation: Australia

- **Several ACCs, coal-fired and combined cycle applications**

Conclusions

Dry Cooling is an important technology for thermal power generation that is increasing in its application. It is anticipated that both direct and indirect dry cooling will continue to be major options for new plant construction in the next few decades, with hybrid cooling installations, including retrofits, also likely to increase.

Input appreciated regarding status / trends with ACCs

SPX

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