Water Conserving Cooling Systems
--Air-cooled Condensers--

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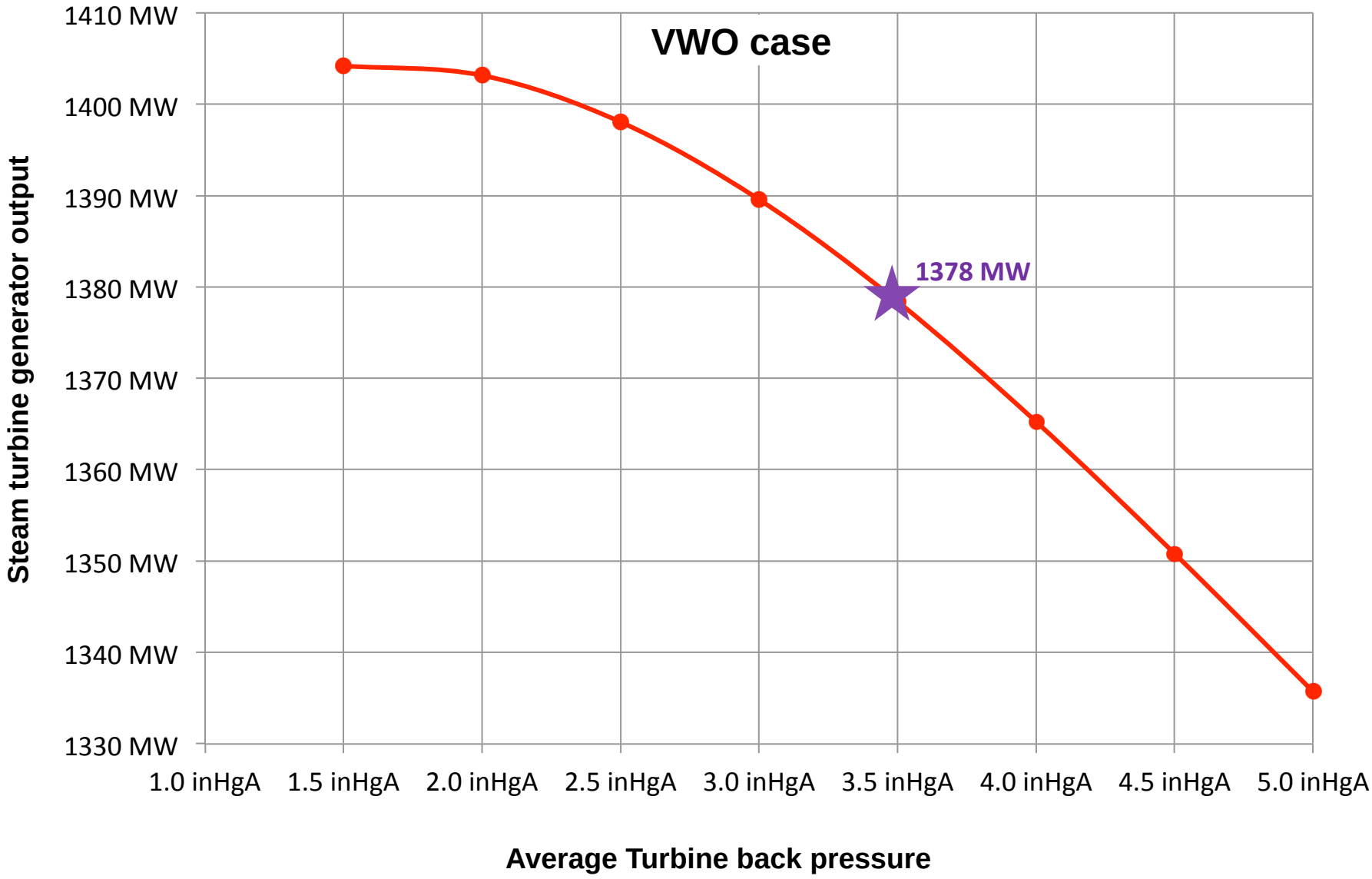
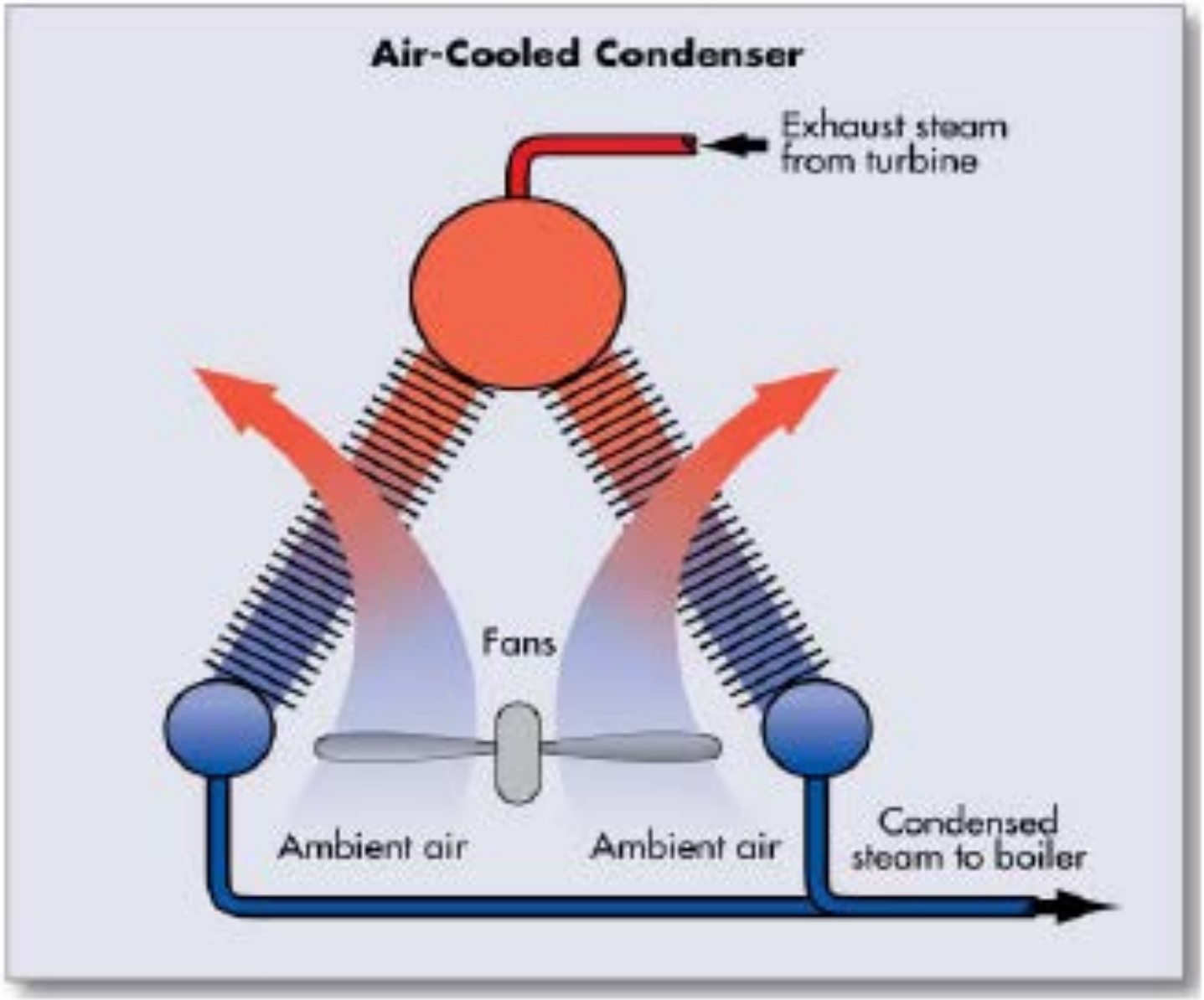
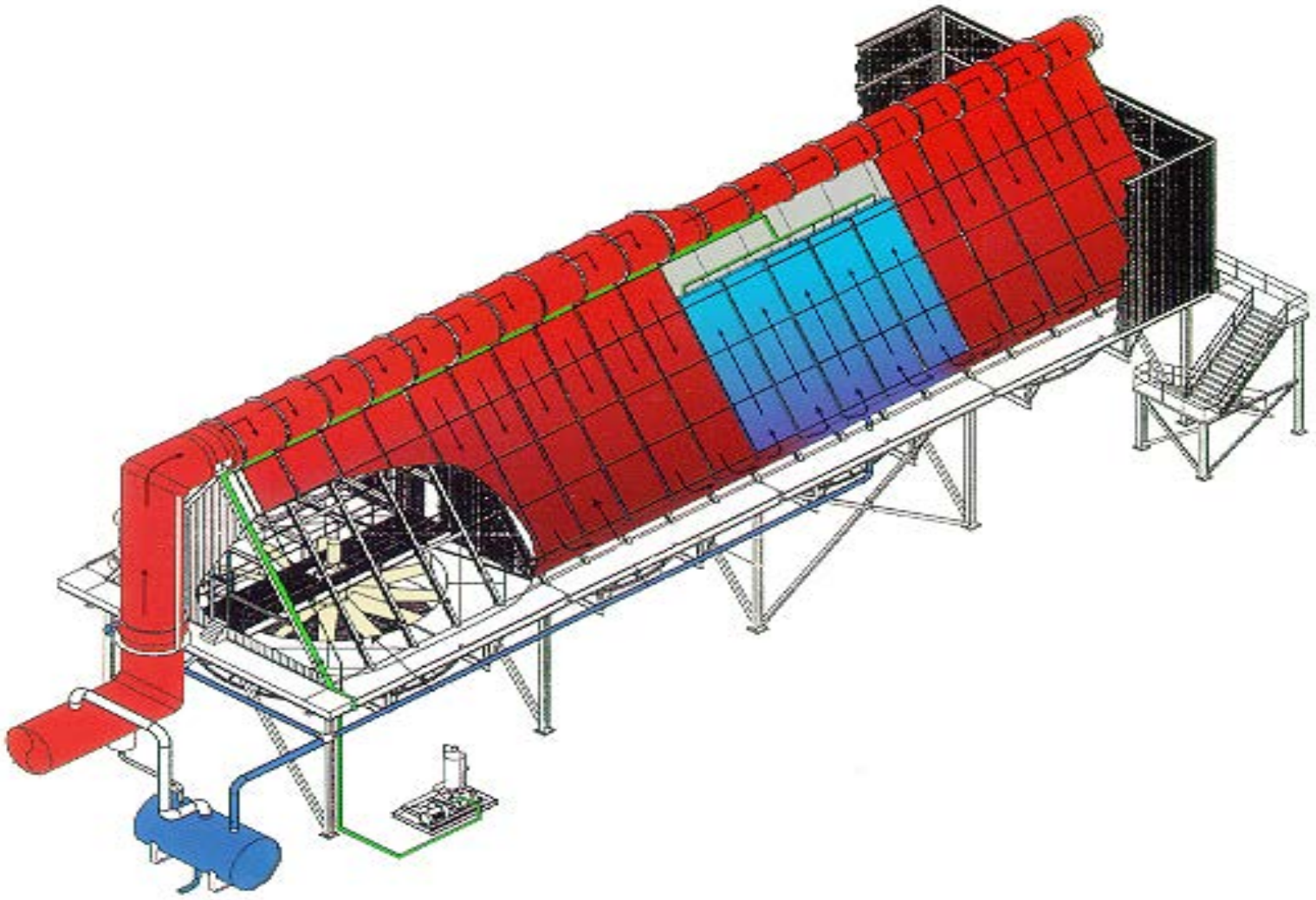
Air-cooled Condensers

- Good things
  - Water conservation
  - Siting flexibility
  - No water supply, treatment, disposal, etc.
- Bad things
  - Plant efficiency/output penalties
  - Cost—capital and operating
  - Size, noise, condensate chemistry, wind, freeze-up
- Nuclear applications??


VWO case
1410 MW
1400 MW
1390 MW
1380 MW
1370 MW
1360 MW
1350 MW
1340 MW
1330 MW
1378 MW
Steam turbine generator output
1.0 inHgA
1.5 inHgA
2.0 inHgA
2.5 inHgA
3.0 inHgA
3.5 inHgA
4.0 inHgA
4.5 inHgA
5.0 inHgA
Average Turbine back pressure

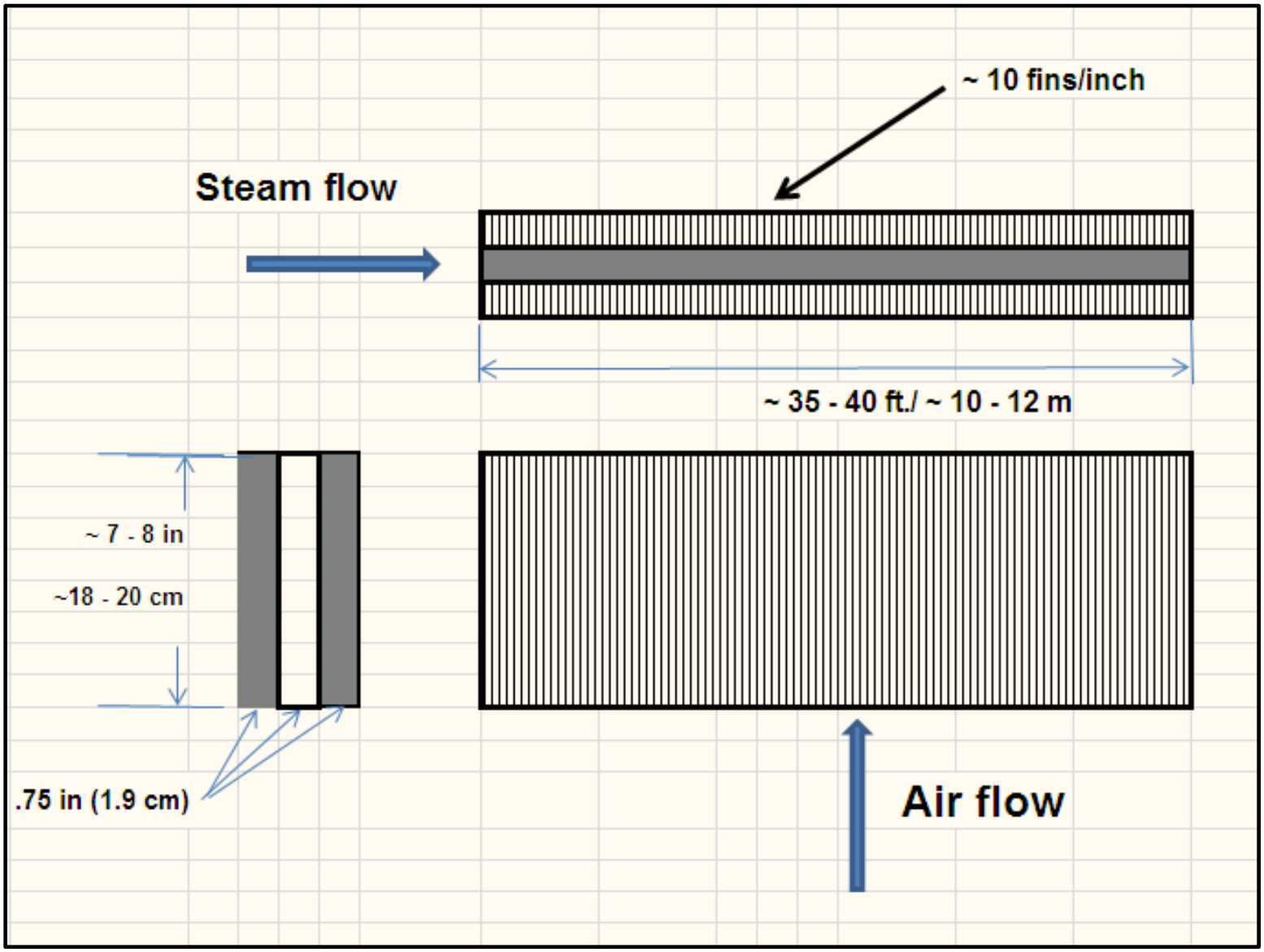

Air-Cooled Condenser
Exhaust steam from turbine
Fans
Ambient air
Ambient air
Condensed steam to boiler



Higgins (nee Bighorn) 550 MW CC plant

ACC Design Specifications				
Item	SI Units		English Units	
Steam flow	315	kg/s	2,500,000	lb/hr
Quality	0.95		0.95	
Backpressure	24	kPa	7	in Hga
Condensing temp	64	C	147	F
1% Dry bulb temperature	43	C	110	F
Elevation	0	m	0	ft

Operating Point				
Quantity	SI Units		English Units	
ITD	21	K	37	F
Steam flow/cell	24		40,000	lb/hr
# cells	60		60	
Air temperature rise	~17	K	~30	F
Air flow/cell	3,500	kg/s	5,800,000	lb/hr
Air flow/cell	2,200,000	m3/hr	1,290,000	acfm
Static pressure	75 - 125	Pa	0.3 - 0.5	in H2O
Fan power/cell	127	kW	170	HP
ACC fan power	7,600	kW	10,200	HP

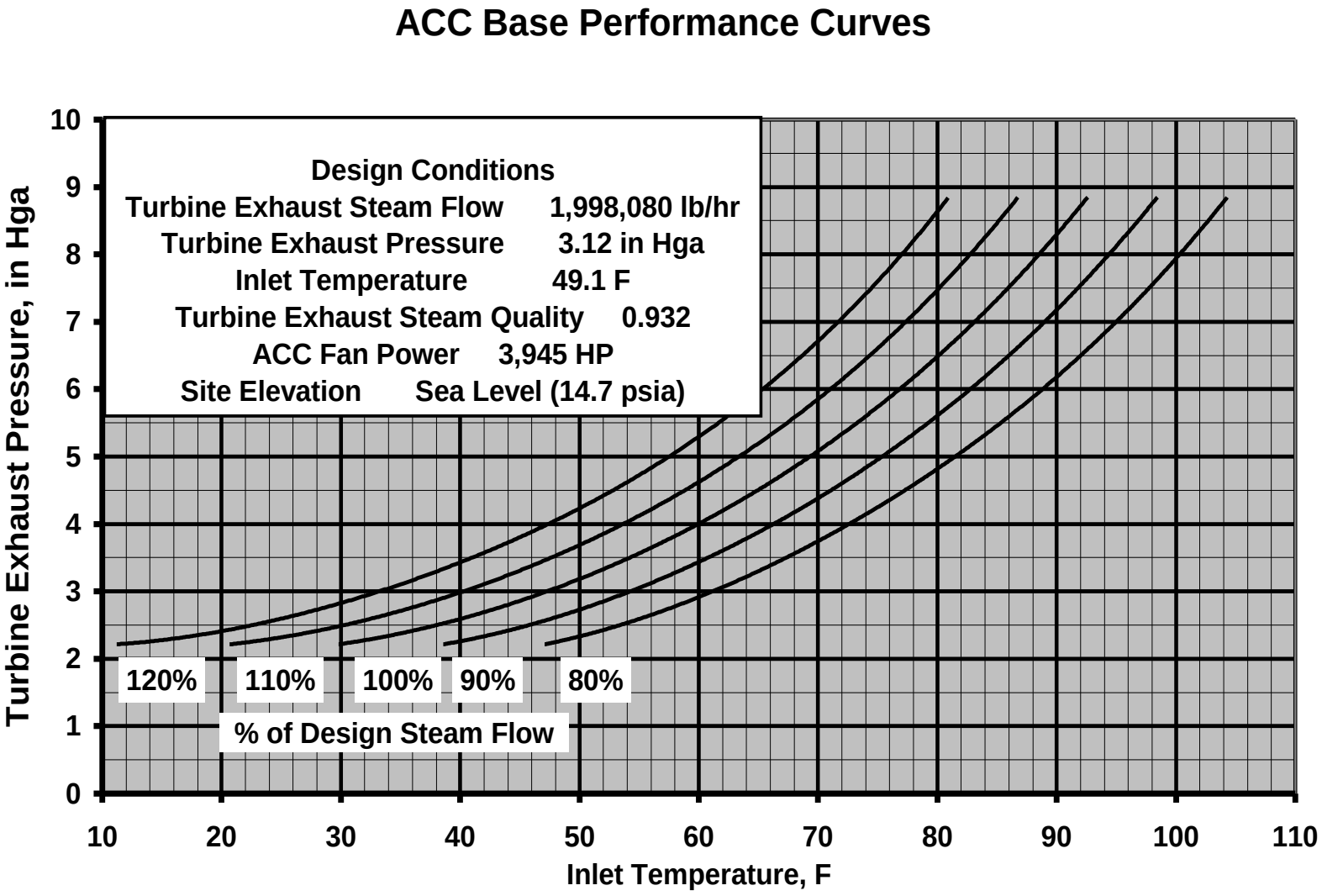


Condensing tube for ACC

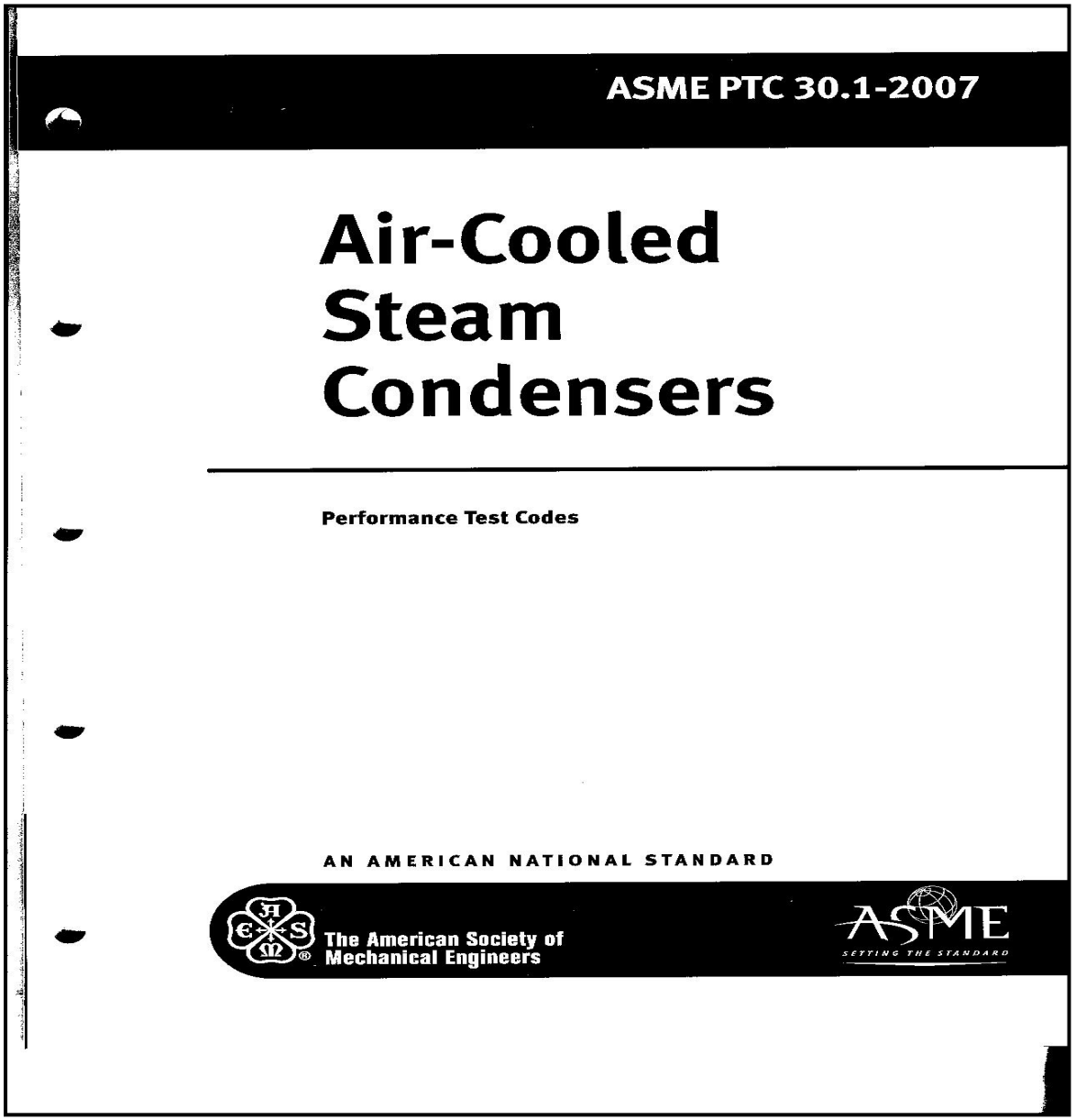
Typical of Single-row Condenser (SRC) design

Some numbers to remember

Item	SI Units		English Units	
Tubes per bundle	40		40	
Bundle width (length)	2.5 (12)	m	8 (40)	ft
Bundles/cell (each side)	5		5	
Bundles/cell	10		10	
Heat load per cell	11,750	kW	4×10^7	Btu/hr
Air-side area per cell	37,000	m^2	400,000	ft^2
Overall heat transfer coefficient (on outside area)	~30	$W/m^2\text{-}K$	~ 5	$Btu/ft^2\text{-}hr\text{-}F$



Illustrative ACC performance curves



ASME Test Code for Air-Cooled Condensers

Front Range, Colorado Springs

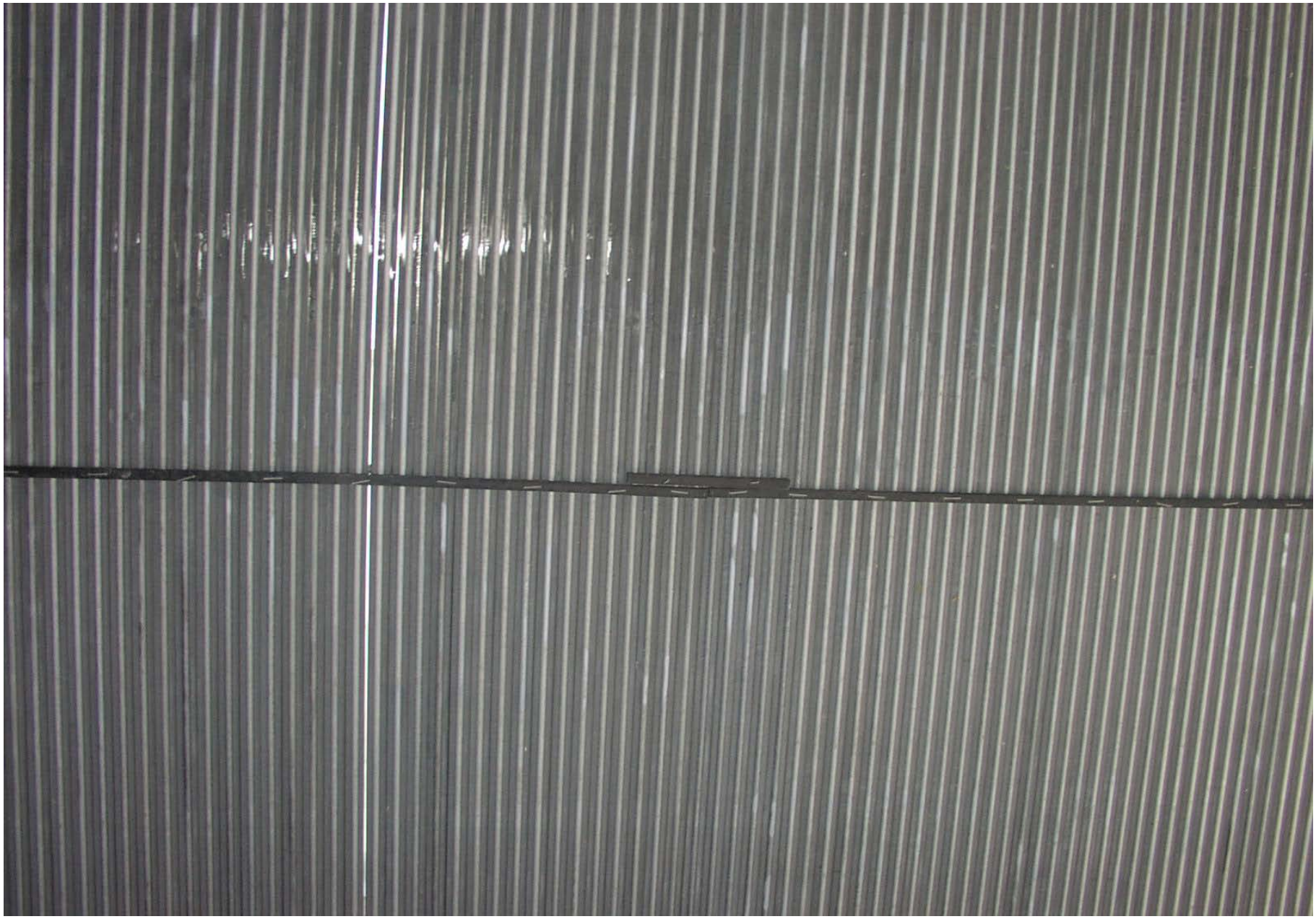
Steam duct and risers

Gas-fired combined cycle plant, Front Range, Colorado

Steam risers

Steam ducts and cells

Catwalk between streets



Tube bundles from inside cell

Bottom of bundles and condensate line

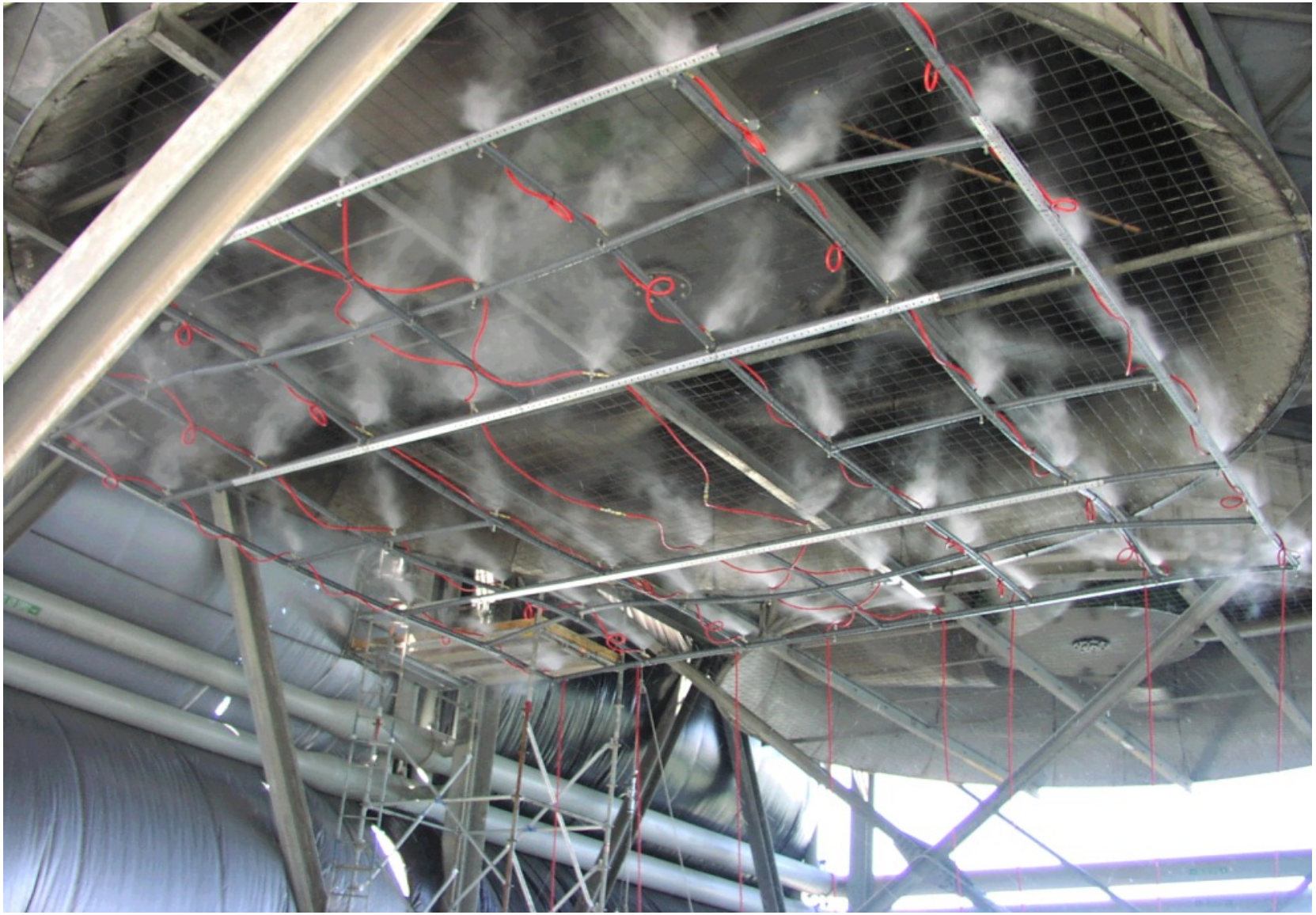
ACC fan--~ 10 m diameter

Typical fan design…..not one of the “low noise” designs

Low noise fan blade

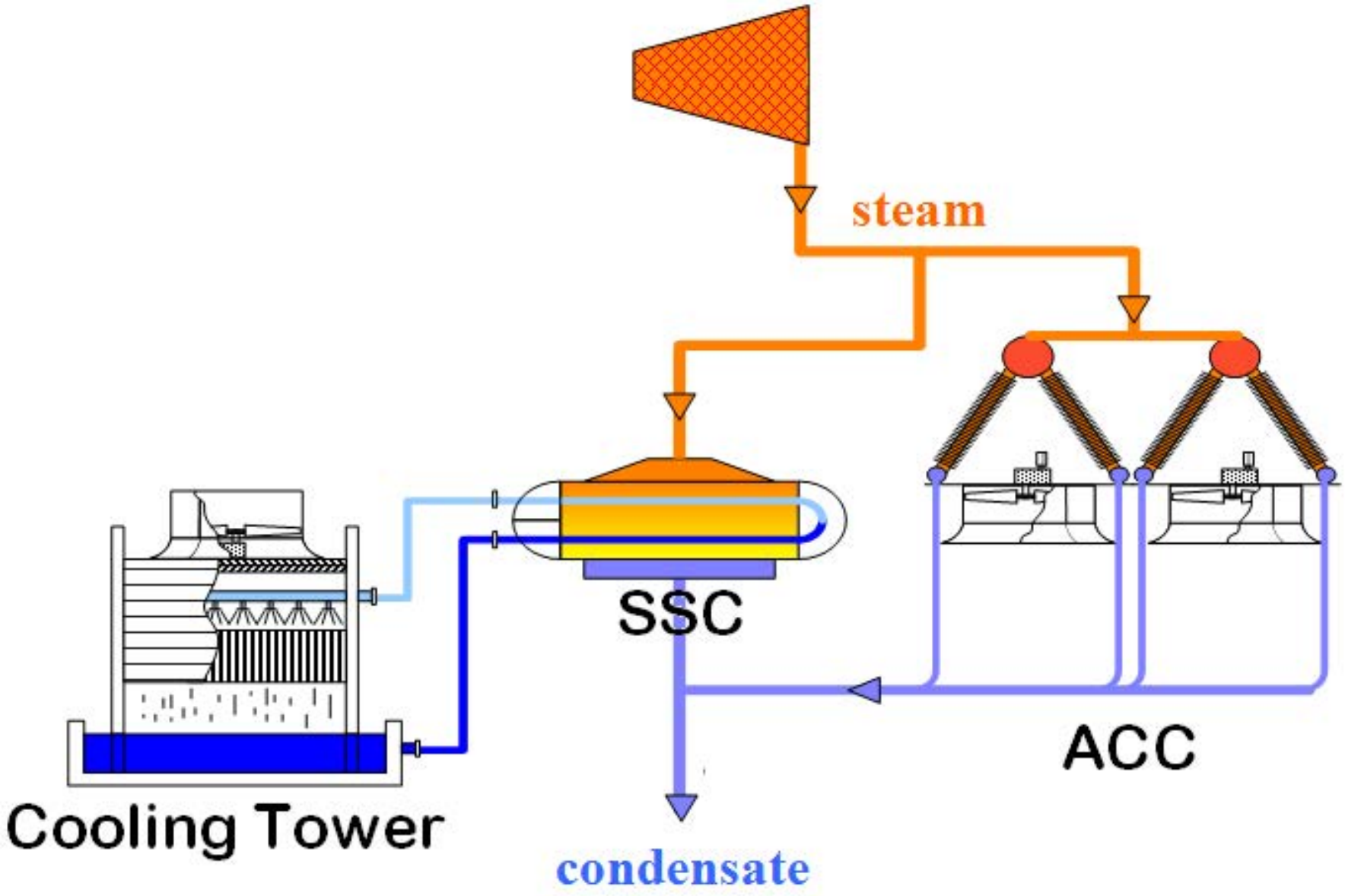
Installed at Crockett Co-Generation Plant

What do you do when it’s hot?



Inlet air cooling with sprays

Testing at Crockett Co-Gen plant

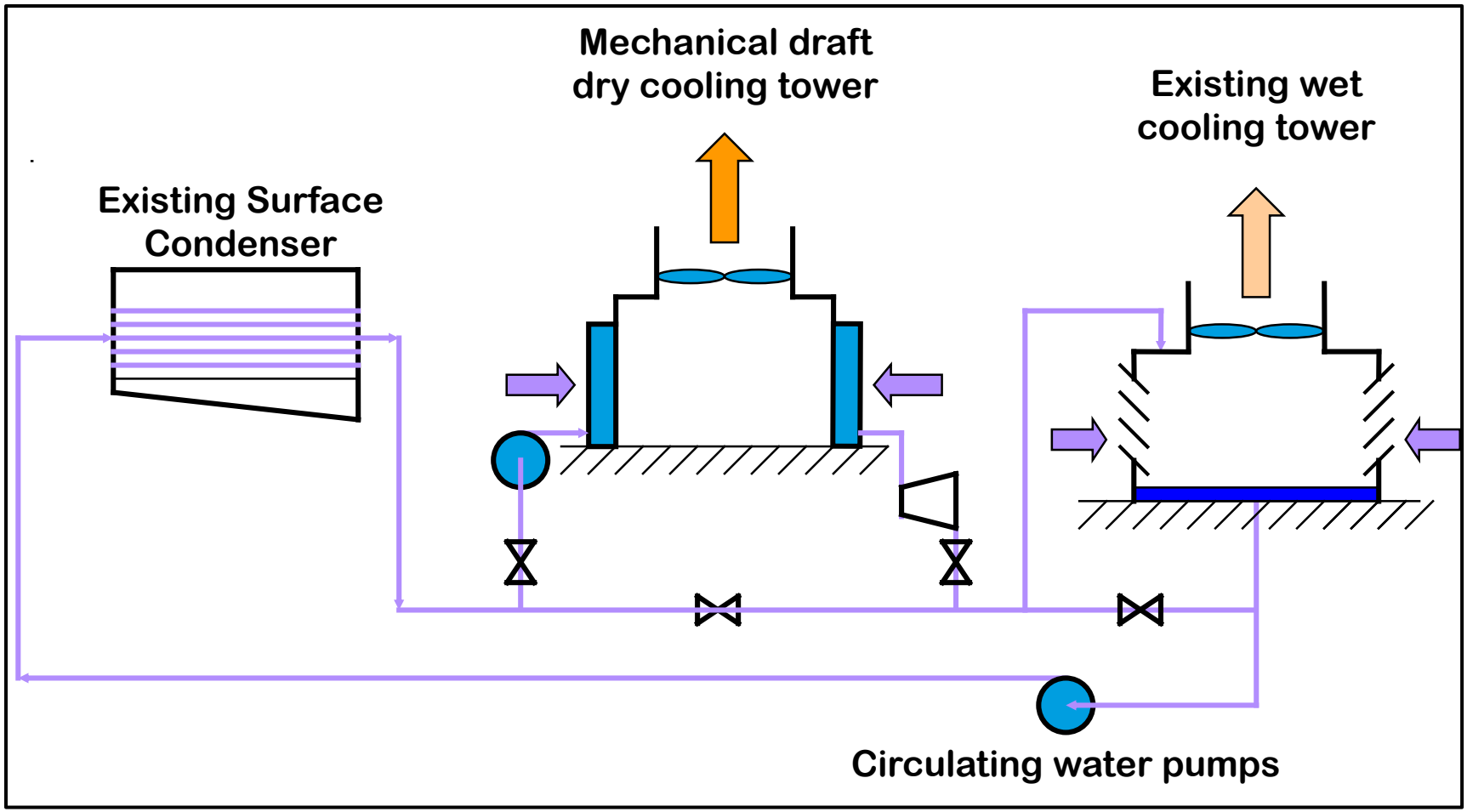

steam
SSC
ACC
Cooling Tower
condensate

Or when the wind blows?

ACC Cruciform windscreen

Windscreen porosity varying with height

What about nuclear?


Mechanical draft
dry cooling tower
Existing wet
cooling tower
Existing Surface
Condenser
Circulating water pumps

Kendal Power Station, South Africa

Natural-draft, indirect dry cooling