EPRI 2008

WSAC Demonstration

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What is a Wet Surface Air Cooler?

- Heat removal device
  - Cooling liquids
  - Condensing vapors

…in a closed-loop system

Wet Surface Air Cooler

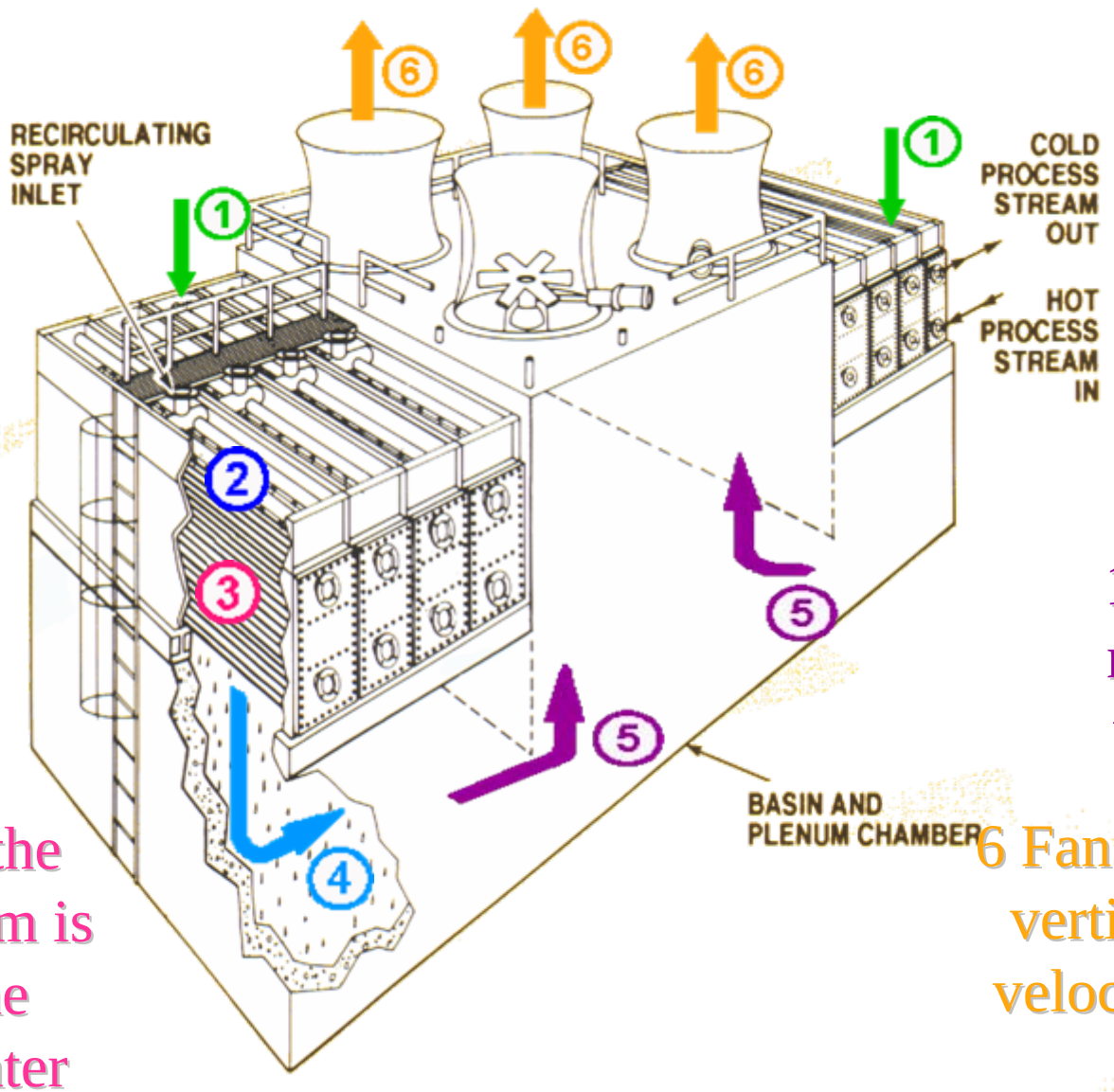
- Where is it applicable?
  - Aux loop cooling
  - Direct vacuum steam condensing
  - Refrigerant condensing

How Does the WSAC Work?

1 Air is induced downward over tube bundles

2 Water flows downward along with the air

3 Heat from the process stream is released to the cascading water



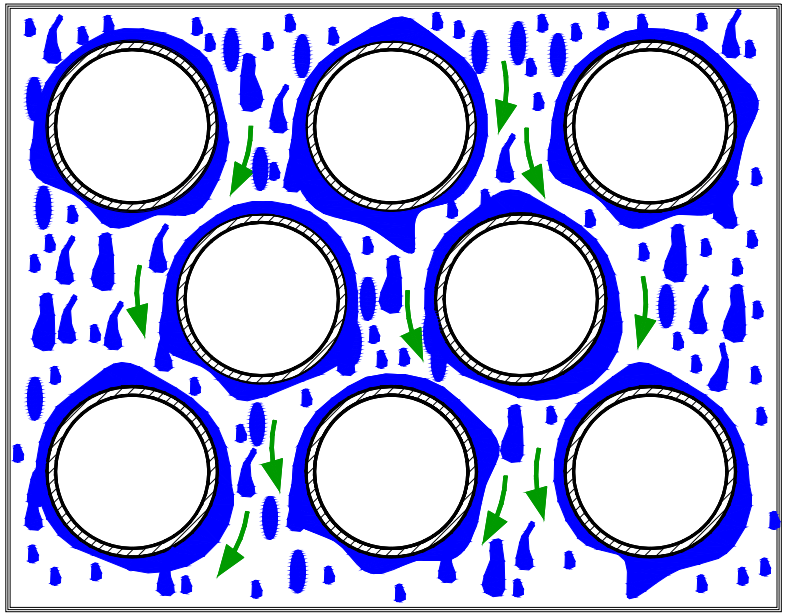
4 Heat is transferred from the cascading water to the air stream via vaporization

5 Air stream forced to turn 180^{o} providing maximum free water removal

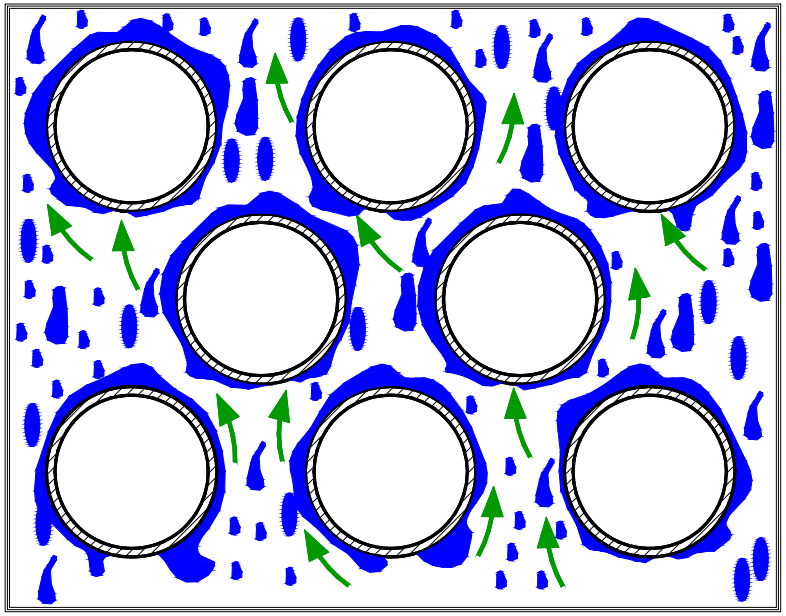
6 Fans discharge air vertically at a high velocity preventing recirculation

Co-Current (WSAC): Counter Current:

↓ AIR ↓ ↓ WATER ↓



↓ WATER ↓



↑ AIR ↑

Water Issues

Spray Water Sources

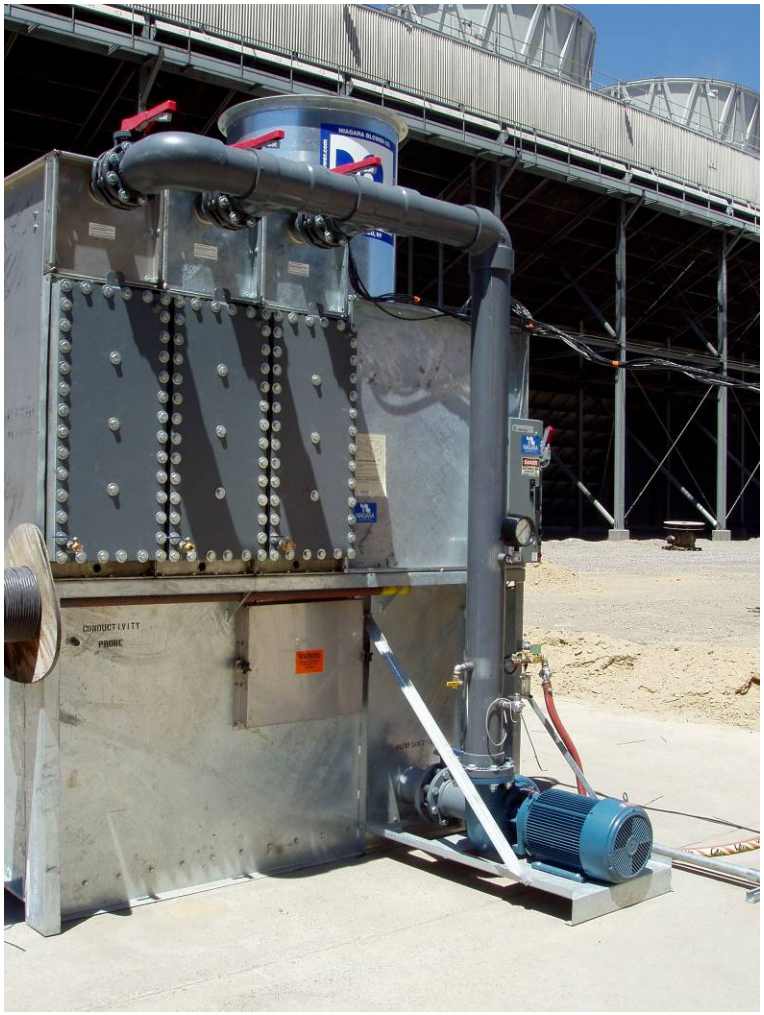
Advantages for sites with poor quality water

- Spray water on the exterior surface of prime surface tubes, not inside heat exchanger
  - Ability to run higher cycles of concentration
- Co-current flow of water and air
  - Even distribution of water over the tubes
- Material selections based on makeup water quality
  - H.D.G.A.F. Steel, Brass, Stainless, Titanium, Sea-Cure

WSAC Demonstration Project

- Objective:
  - Validate water quality limits in a WSAC
- Location:
  - New Mexico power plant
  - Funded by EPRI – NETL
- Methods:
  - Monitor unit performance using different sources of spray water makeup:
    - Cooling tower blowdown (river water makeup)
    - “Produced” water from mining process (future)

WSAC Demonstration Project

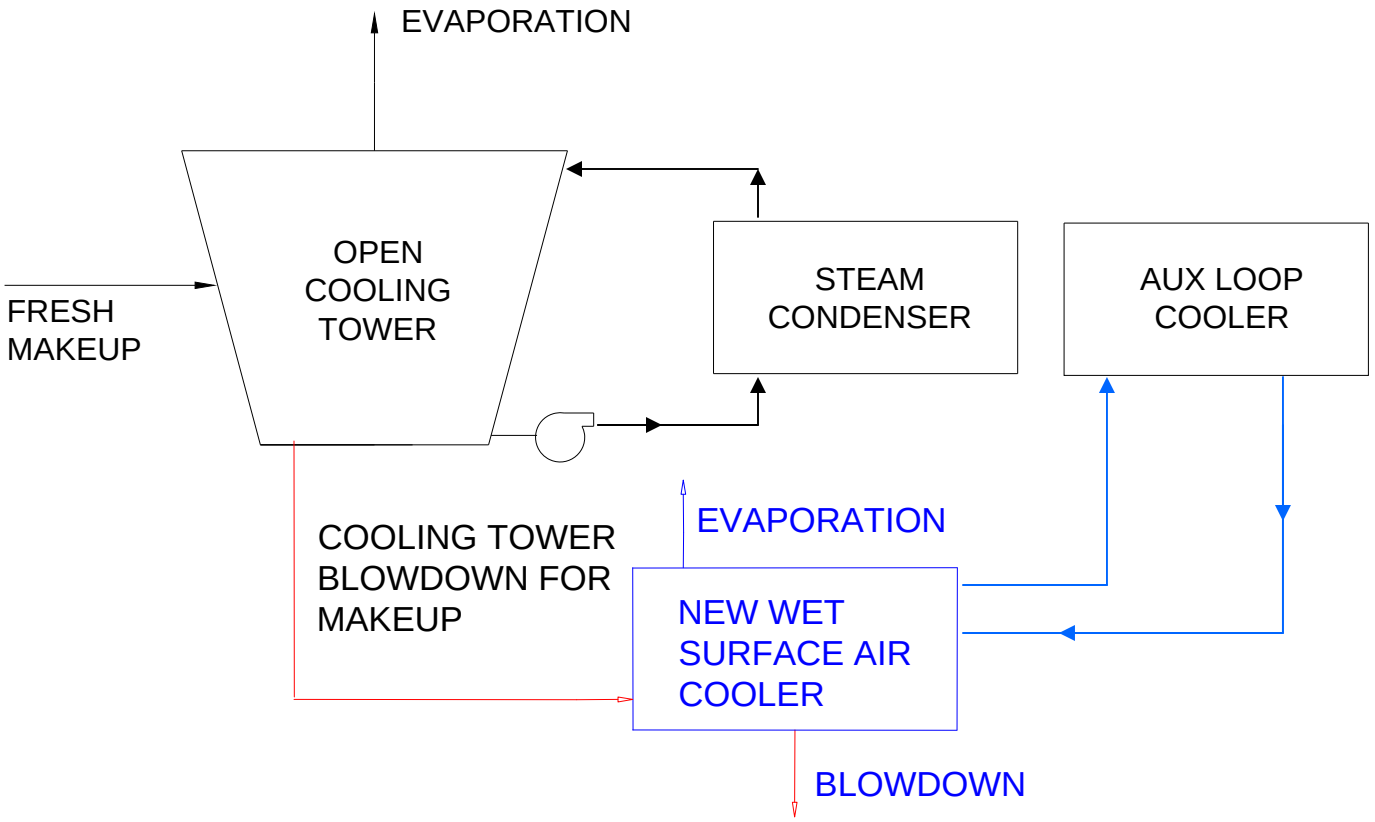


WSAC Demonstration Project
New Mexico Power Plant

- WSAC tube materials
  - 304 / 316 / 2205 Duplex SS
  - 90/10 Cu-Ni; Titanium; Sea-Cure
- Results:
  - River water makeup
    - 5-7 cycles of concentration
    - Additional 7 cycles of concentration in WSAC

NO DEGRADATION IN THERMAL PERFORMANCE

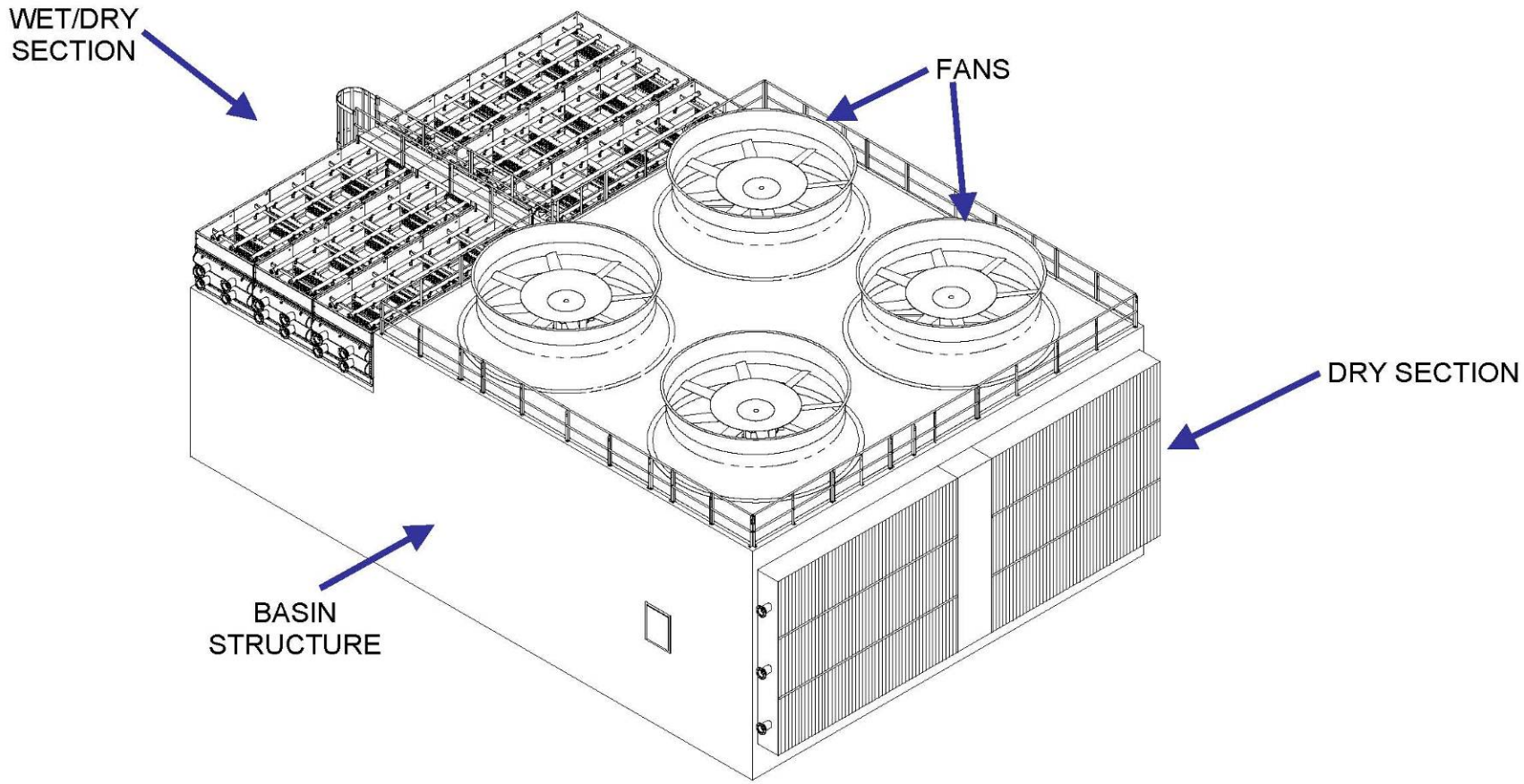
Reducing Water Makeup in Existing Open-Loop Systems



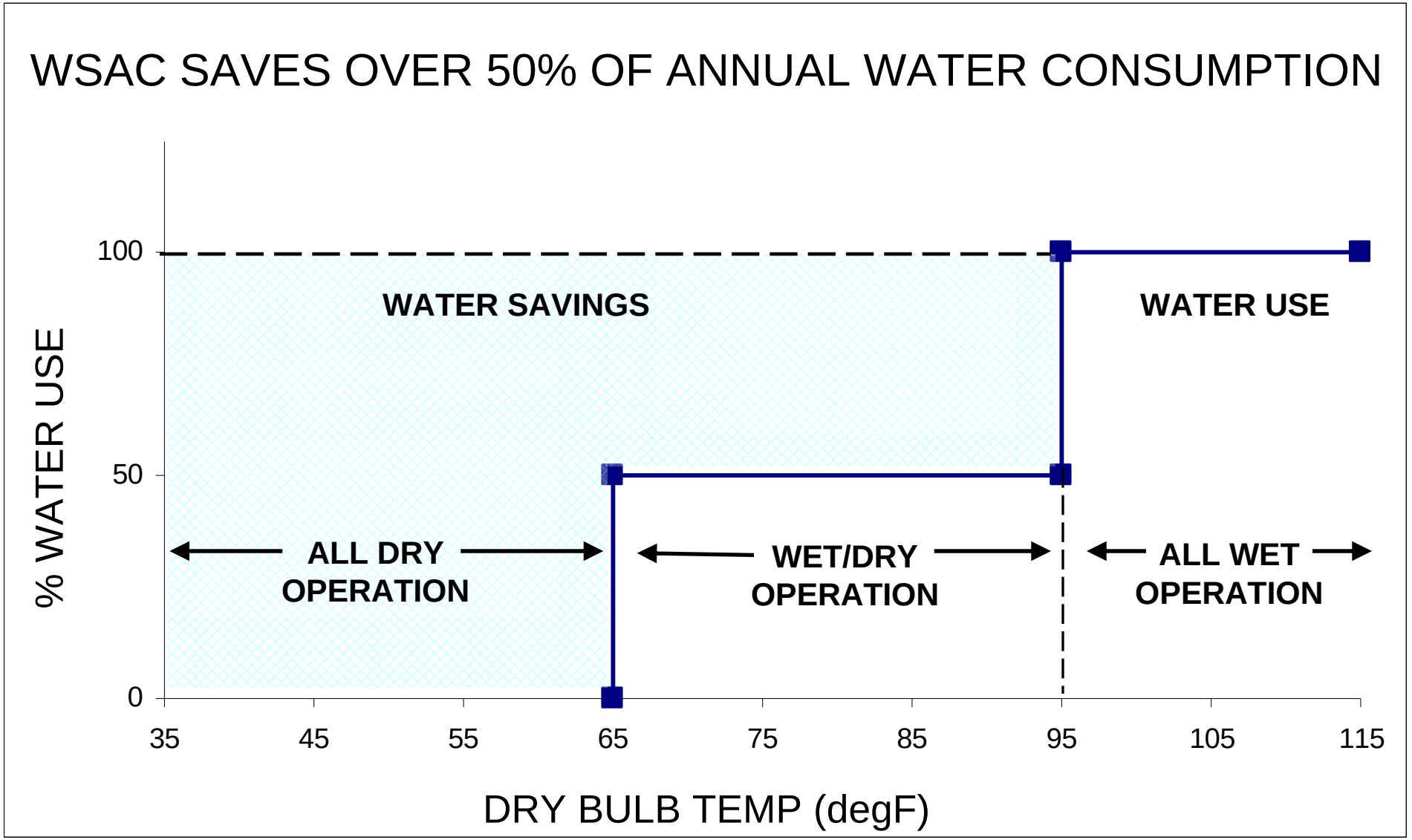
Aux Loop Cooler

Dry/Wet (Hybrid) WSAC

Reduces cooling system water consumption by up to 50%



Water Savings Using Hybrid WSAC

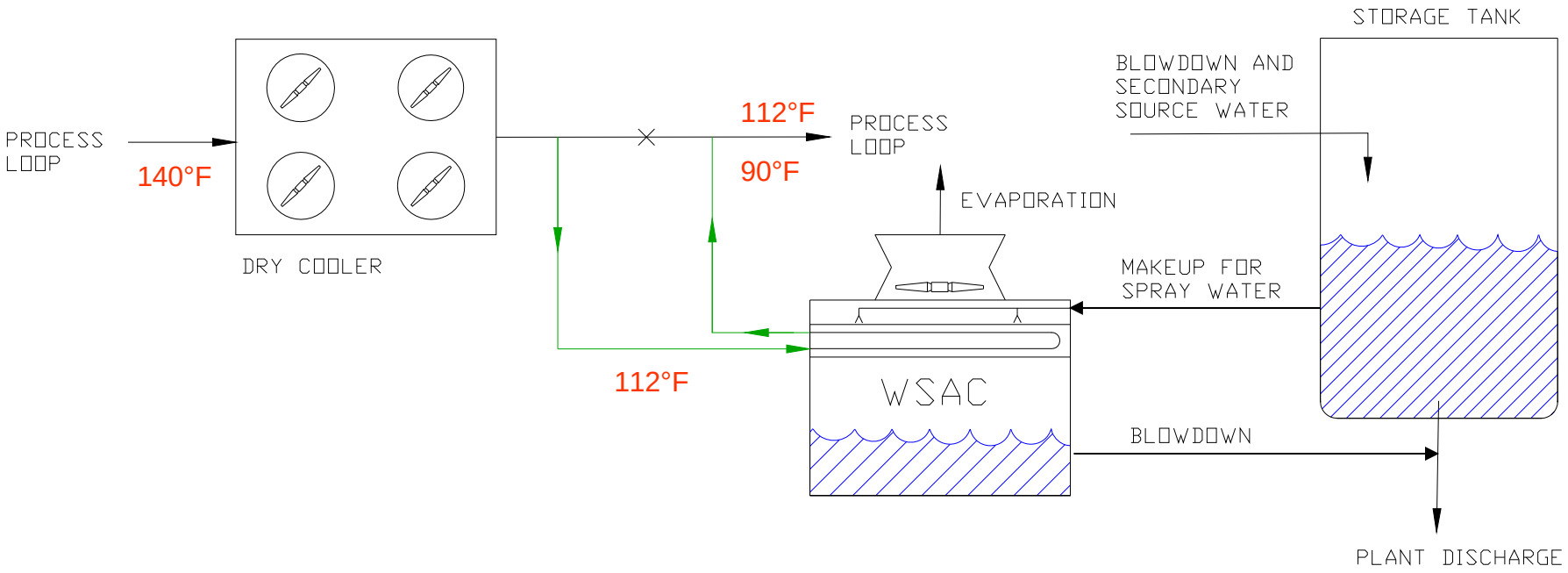


Aux Cooler Performance Temperatures

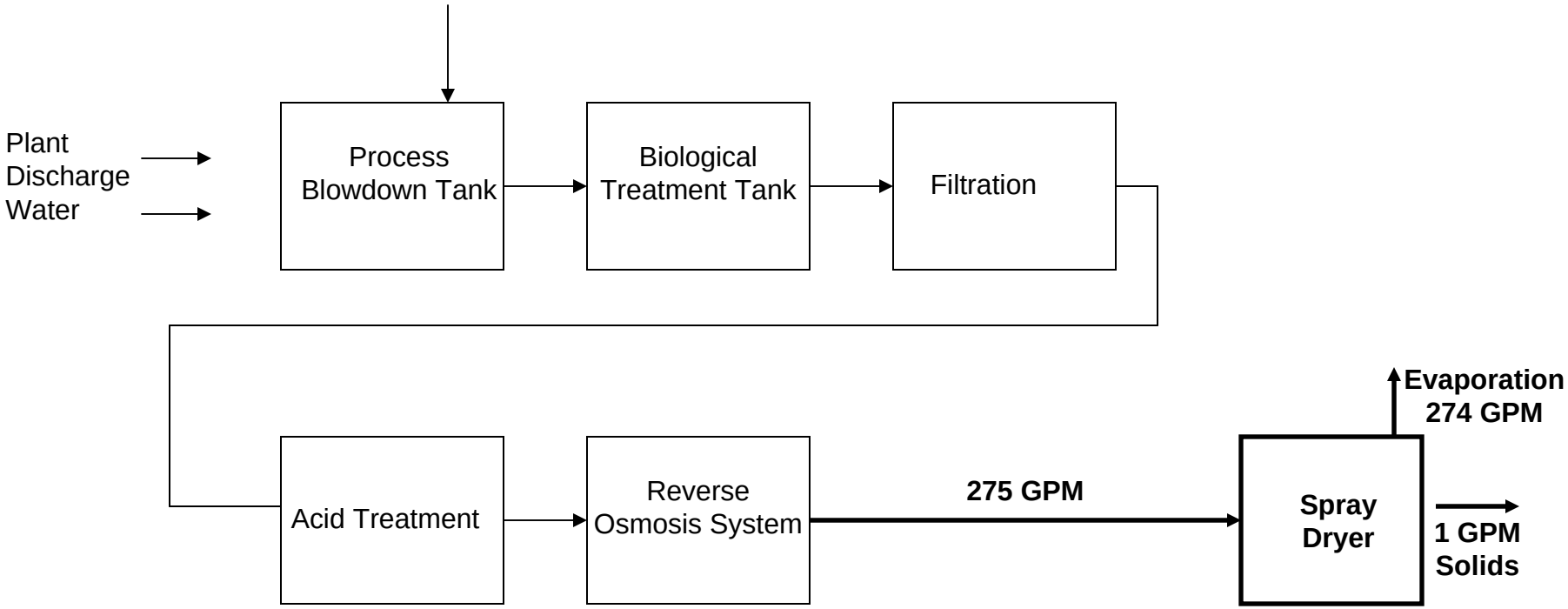
Ambient Conditions: 92°F Dry Bulb --- 80°F Wet Bulb

Process Loop Conditions: 140°F in --- 112°F out

NEW Process Loop Conditions: 140°F in --- 90°F out



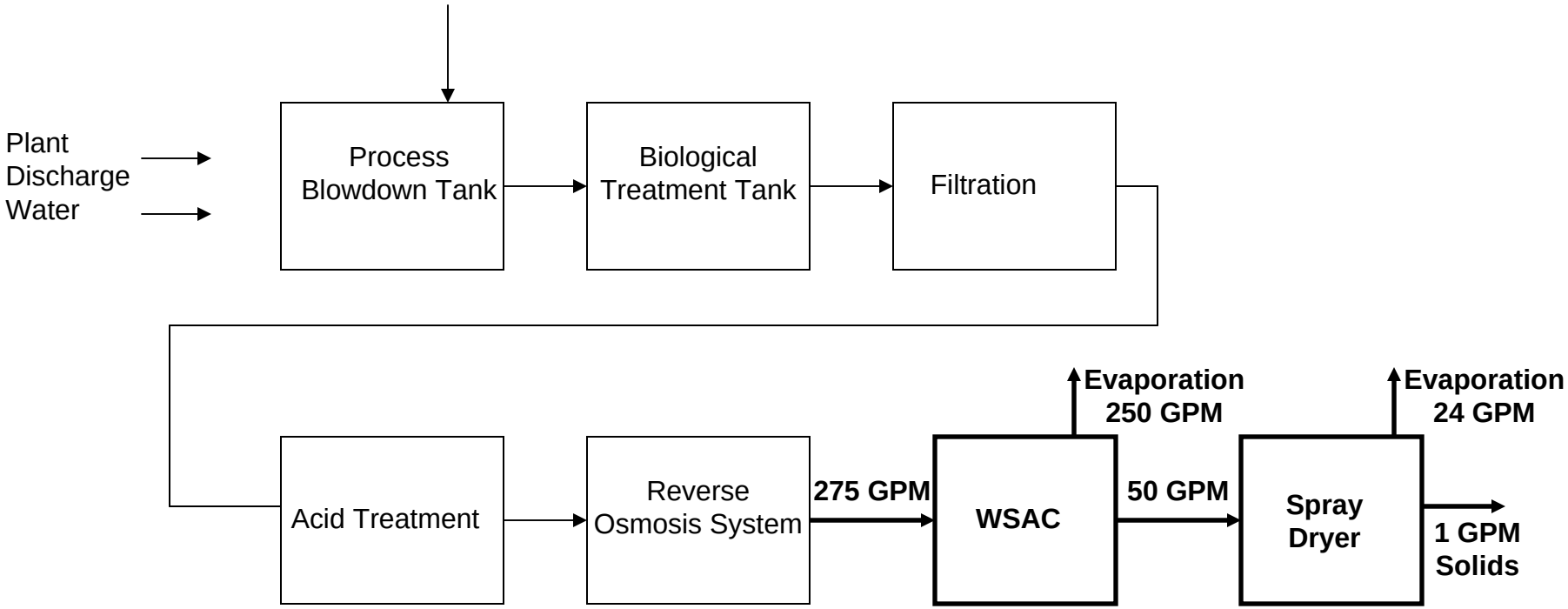
WSAC as a 1st Stage Evaporator



Equipment cost $20,000,000

Operating cost $3,000,000/yr

WSAC as a 1st Stage Evaporator

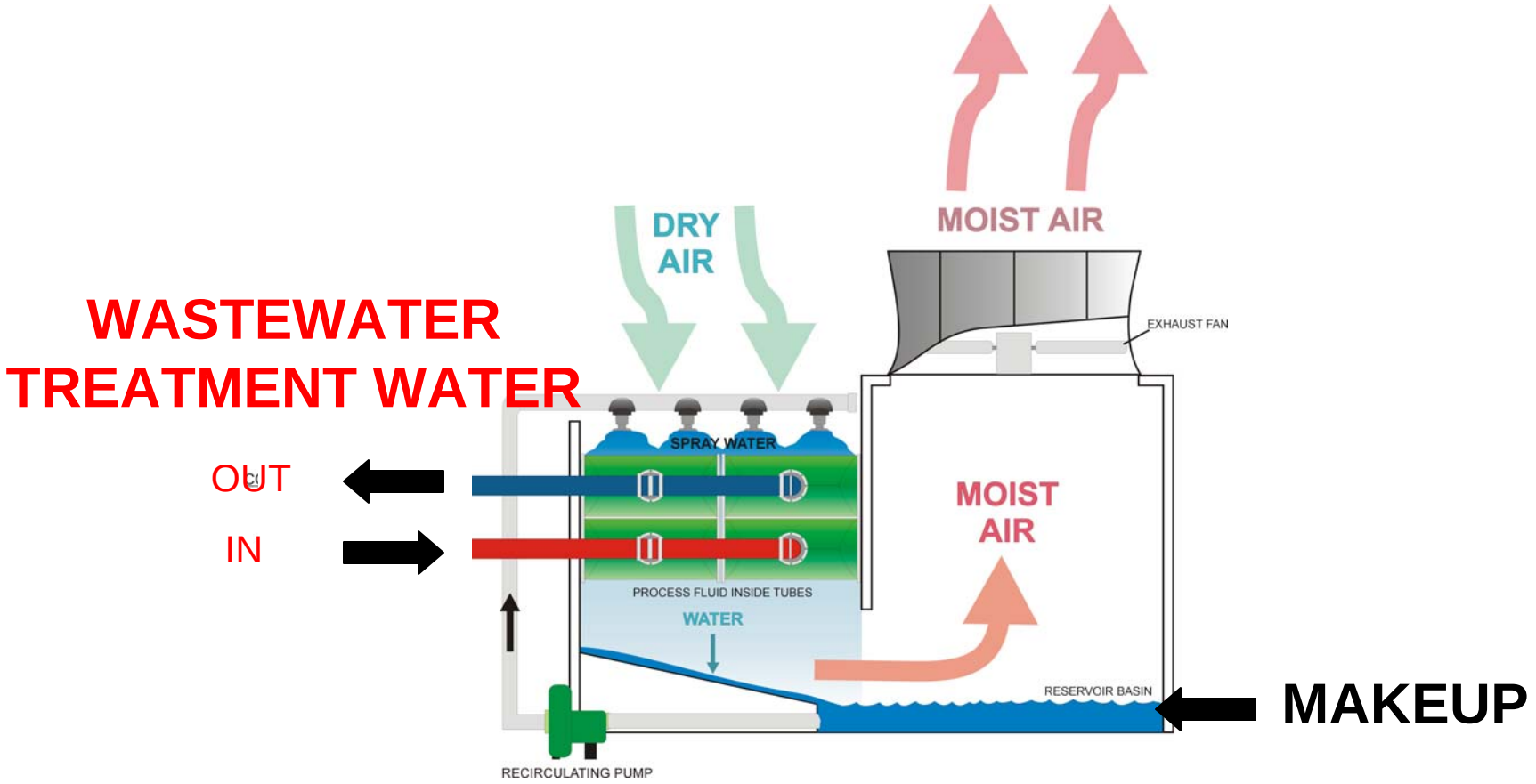


Equipment cost $10,000,000

Operating cost $1,000,000/yr

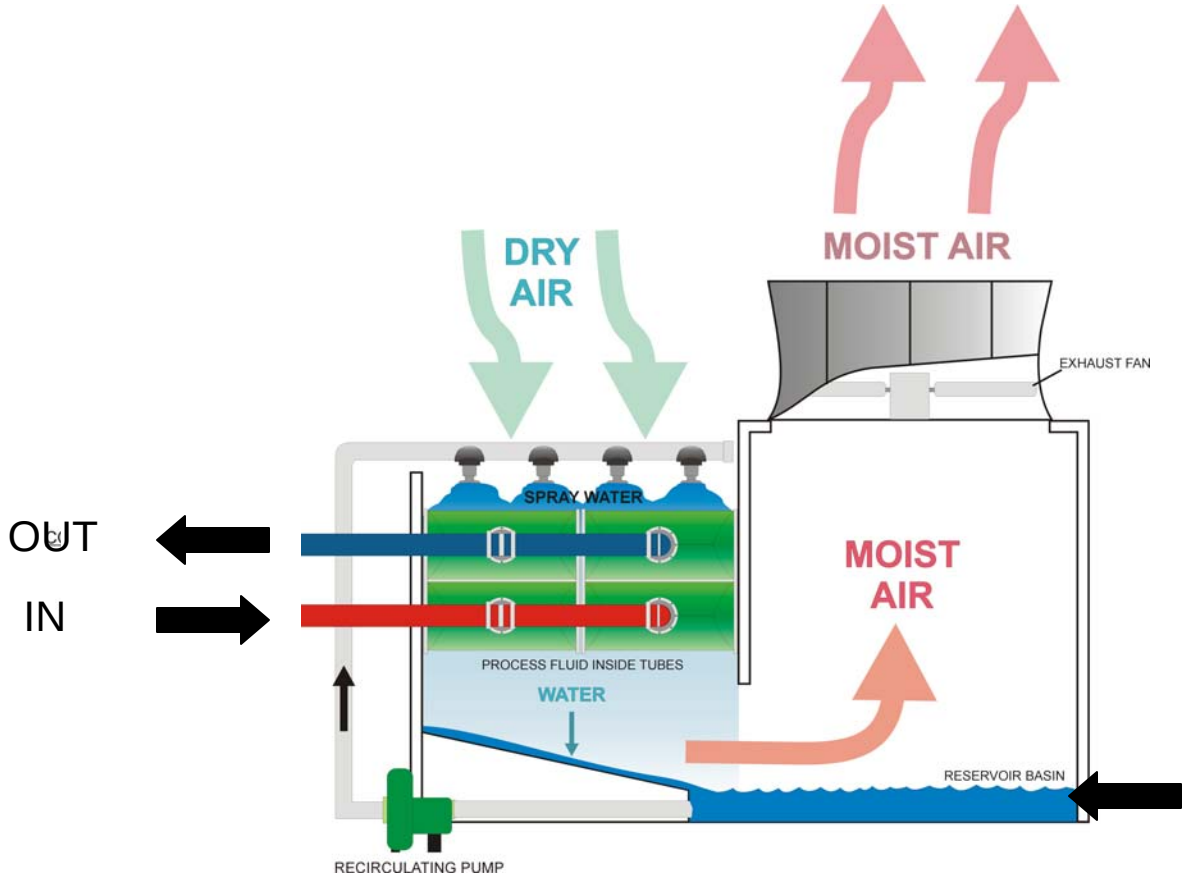
Cooling Water Treatment Streams

In a Closed-Loop System



Using Reclaimed Water

For Spray System Makeup

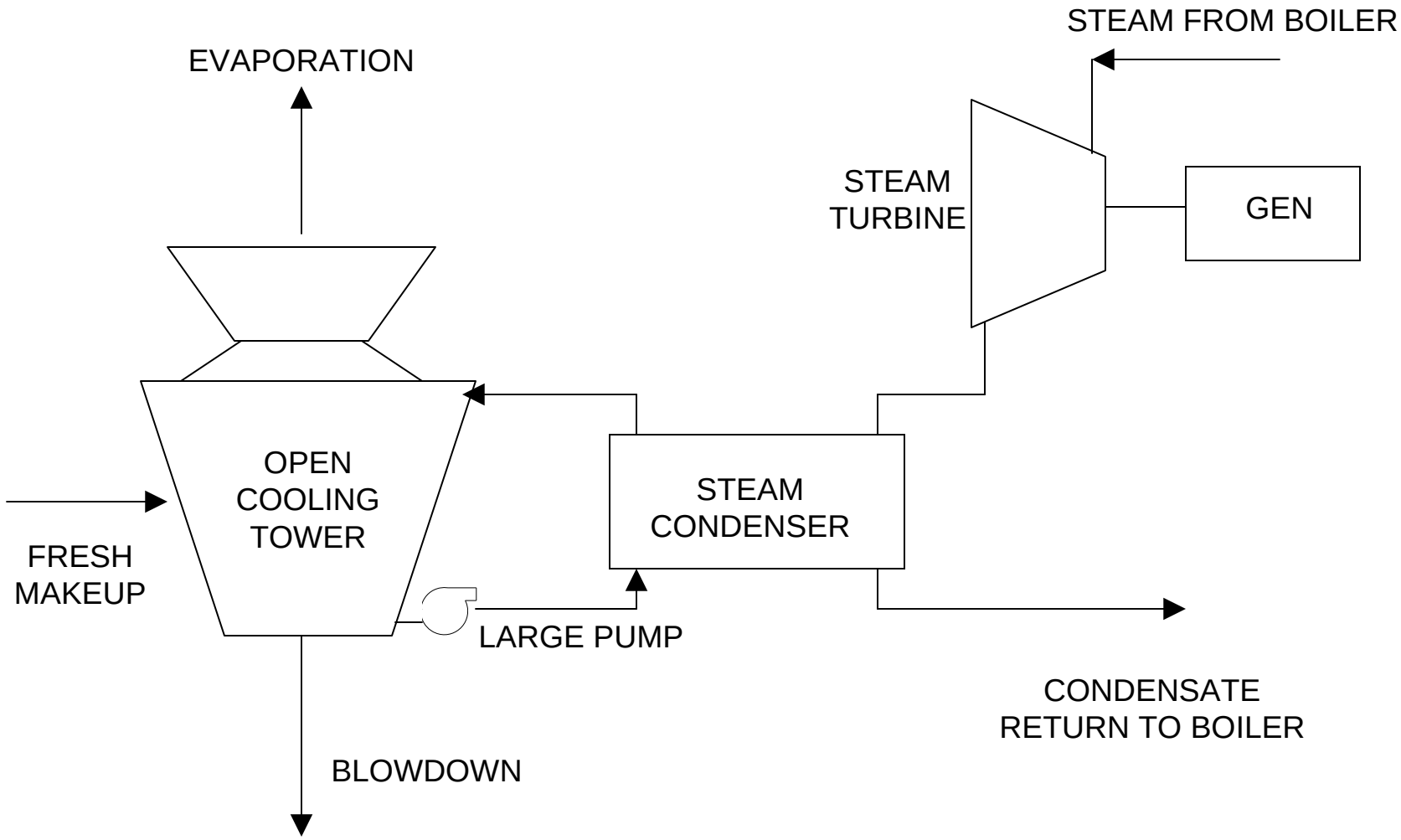


MAKEUP

- PRODUCED WATER
- FGD WATER

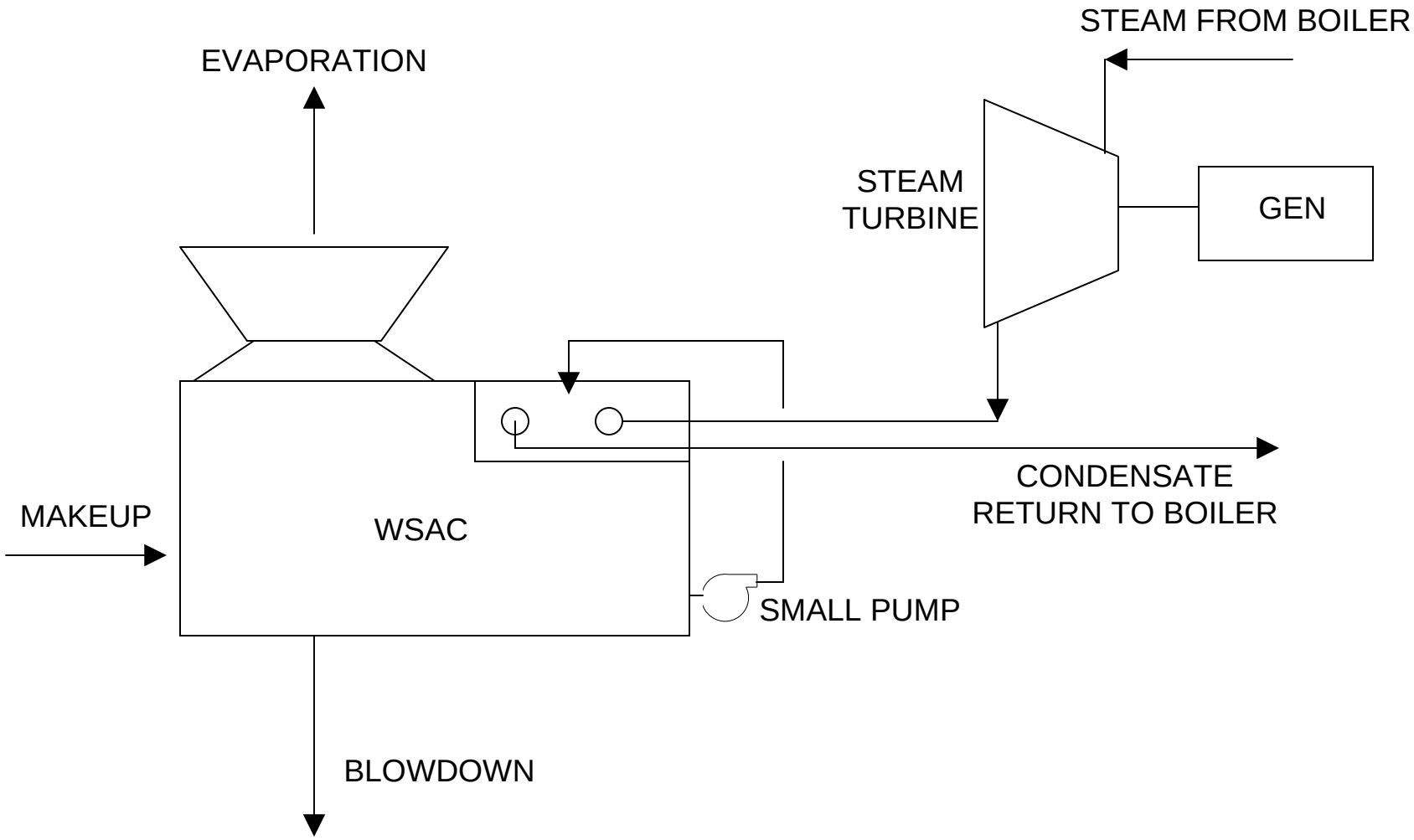
Solar Power Plant

Cooling Tower/Heat Exchanger Steam Condenser

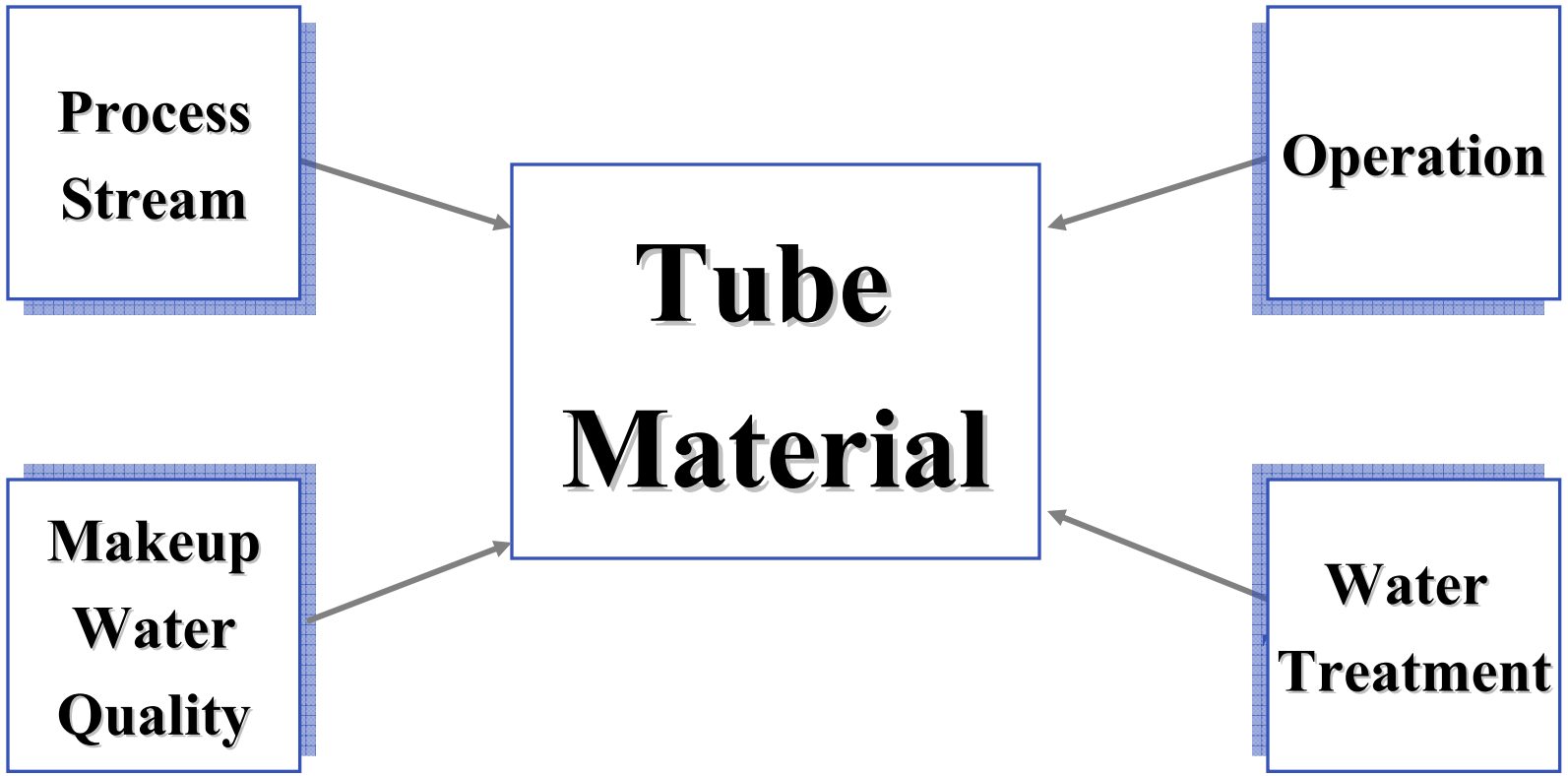


Solar Power Plant

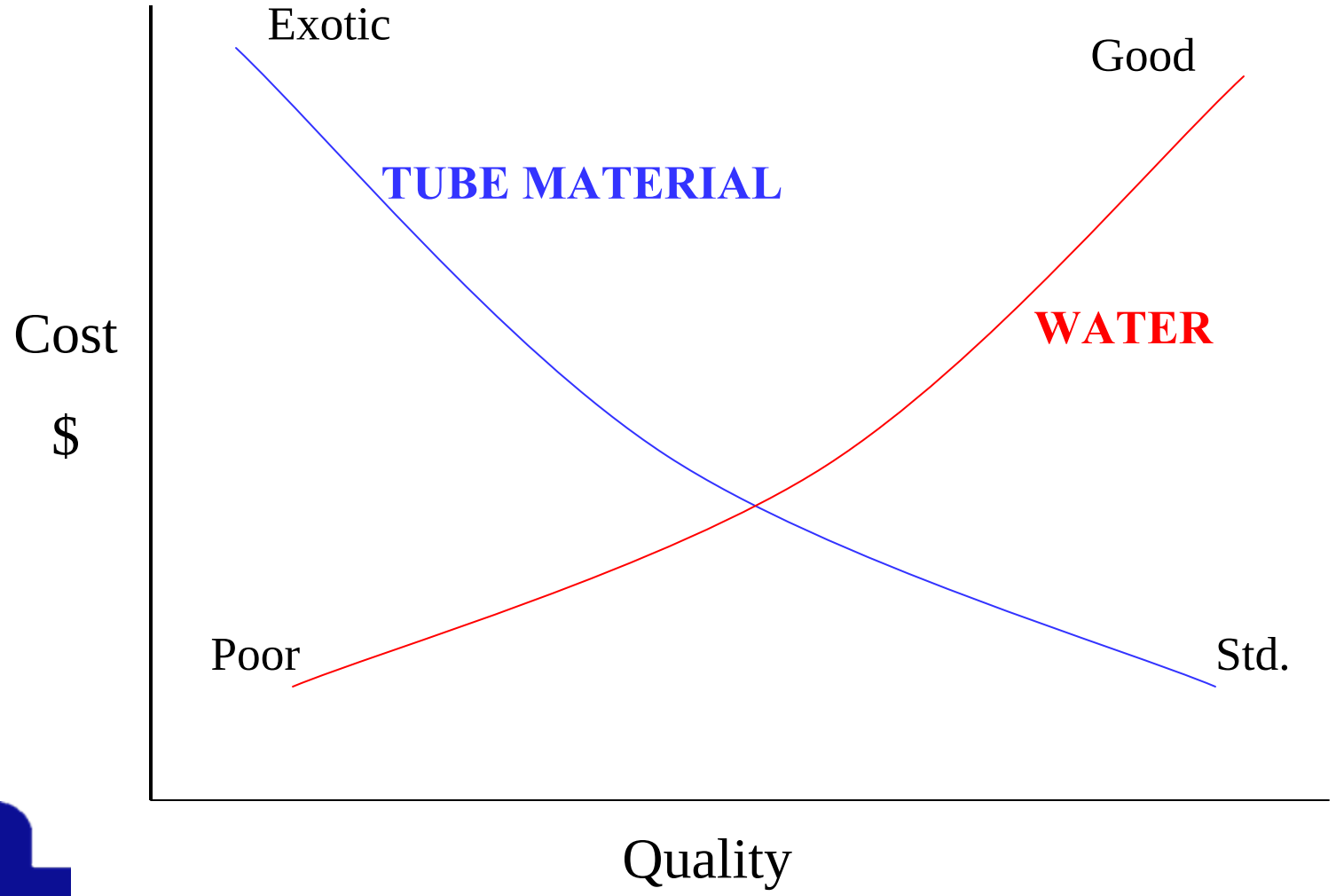
WSAC Steam Condenser



Design Considerations



Cost Analysis
Water Quality & Tube Material



Water Issues

Spray Water Sources

- Blowdown from cooling towers and boilers
- Waste streams from demineralizers, HRSG and RO
- Plant effluent or municipal wastewater
- Agricultural runoff
- Produced water
- Brackish water
- Seawater
- FGD wastewater

Summary

- More efficient cooling/condensing
- Improved heat rate
- Less pumping HP
- Lower carbon footprint
- Less maintenance
- Lower water treatment costs
- Water savings…
    - Purchase…disposal

Additional Water Conservation Opportunities

- Blowdown from cooling towers (COMPLETED)
- Produced water from drilling or mining operations
- FGD water evaporator
- Reclaimed/degraded water

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