COOLING TOWER

Steven Kang
Steven.kang@mnv.com.sg

Agenda

1. Types Of Cooling Tower
2. Cooling Tower Performance
3. Layout Considerations

TYPES OF COOLING TOWER

Definition of a Cooling Tower

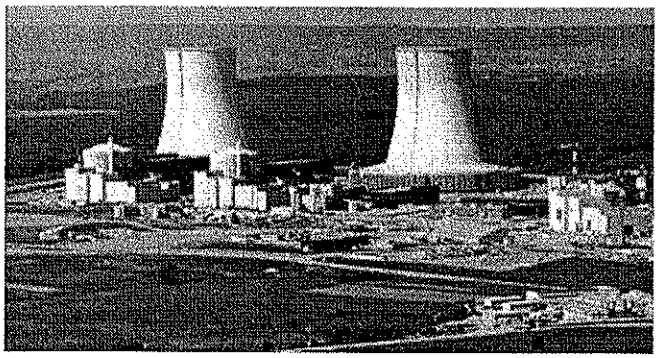
"Heat transfer device, often tower-like, in which atmospheric air cools warm water, generally by direct contact (evaporation)."

ASHRAE Terminology of HVAC&R

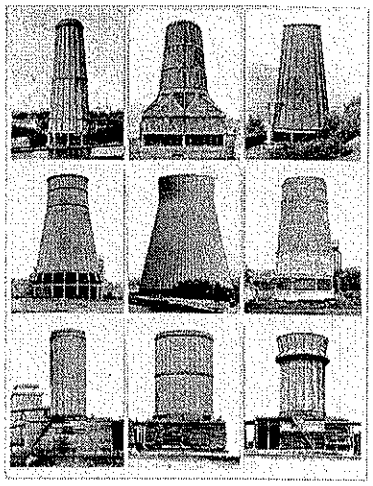
Cooling Tower Types

Measurement & Verification Pte Ltd

Natural Draught Tower



Old Cooling Towers



Induced Draft Cross-flow Tower

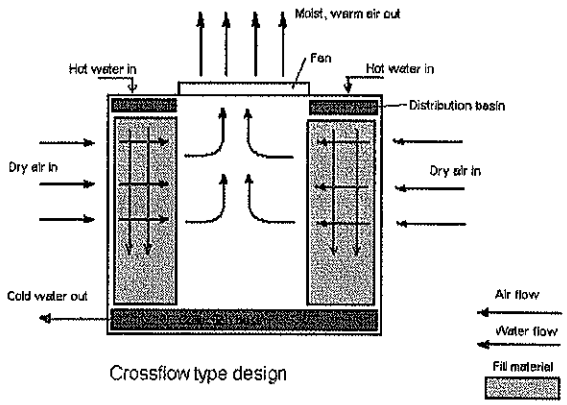
Measurement & Verification Pte Ltd

Air Movement

- Air is induced (drawn through) through the cooling tower infills
- Horizontally through the fill, across the downward fall of the water.

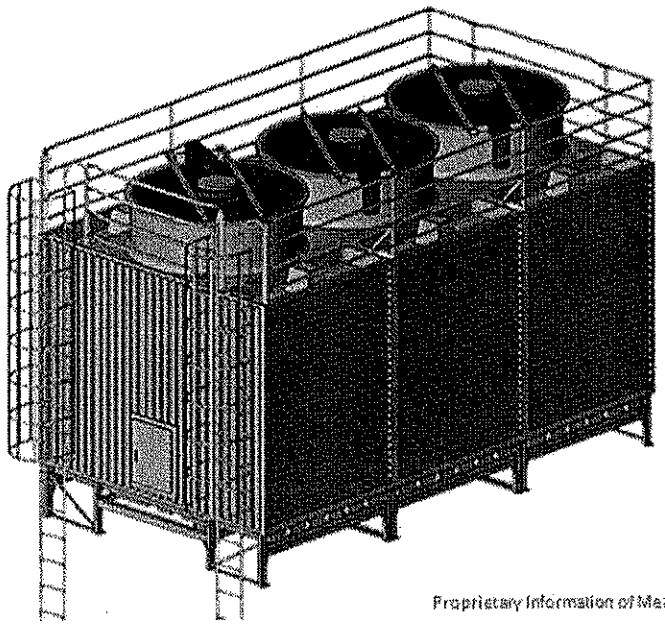
Water Distribution System

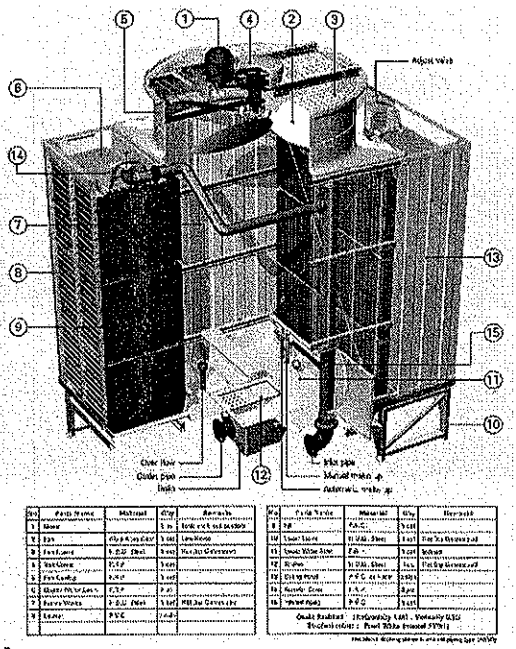
- Hot water is distributed to the fill by gravity through metering orifices in the floor of the inlet basin. There is no pressure spray distribution system.
- The internal pressure component of pump head is insignificant because maximum flow is achieved by gravity.



Crossflow type design

Induced Draft Cross-flow Tower





Induced Draft Counter-flow Tower

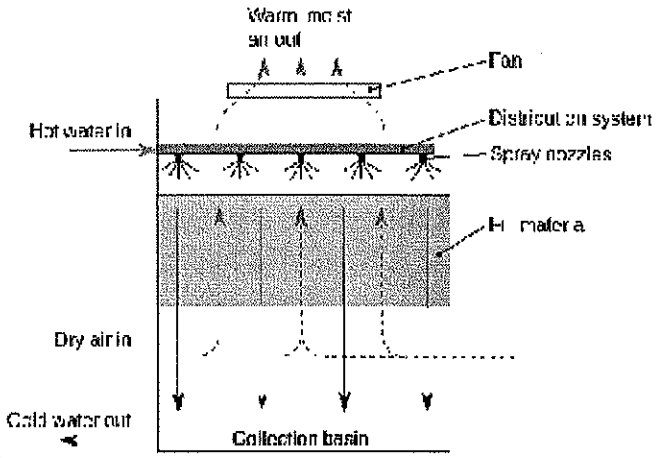
Air Movement

- Air is induced (drawn through) through the cooling tower infills.
- The air movement is vertically upward through the fill, counter to the downward fall of the water.

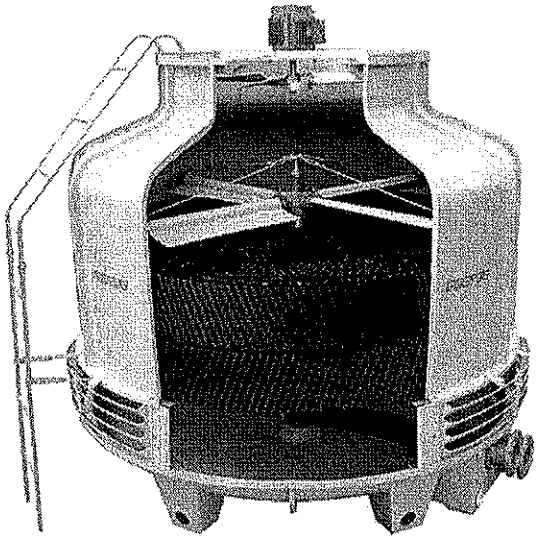
Water Distribution System

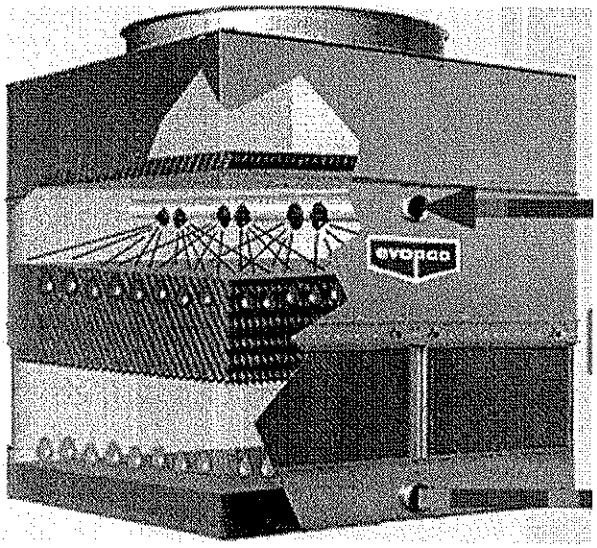
- Counterflow towers use a high pressure spray nozzle hot water distribution system to achieve water coverage of the fill.
- The nozzle spray pattern is sensitive to changes in water flow, and consequent change in nozzle pressure.

Counterflow towers typically have a smaller footprint than crossflow owers, but require additional height, static lift, and dynamic head to achieve the same cooling effect.



Induced Draft Counter-flow Tower





Forced Draft Counter-flow Tower

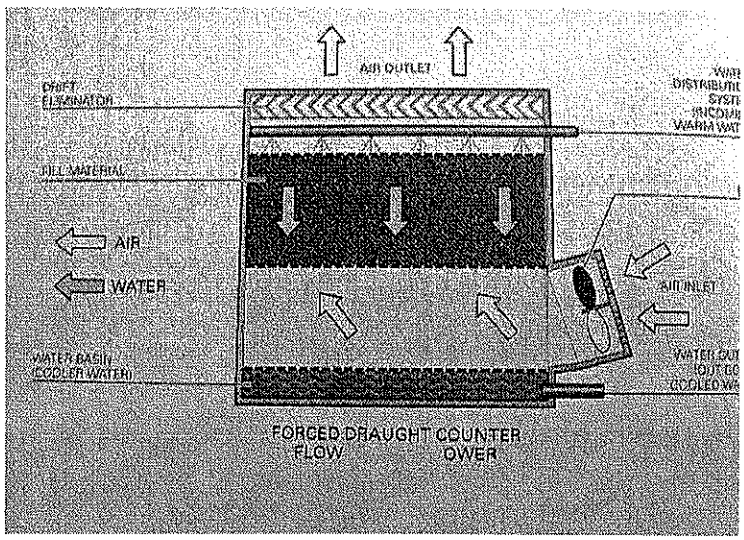
Air Movement

- Air is forced (pusedh through) through the cooling tower infills
- The air movement is vertically upward through the fill, counter to the downward fall of the water.

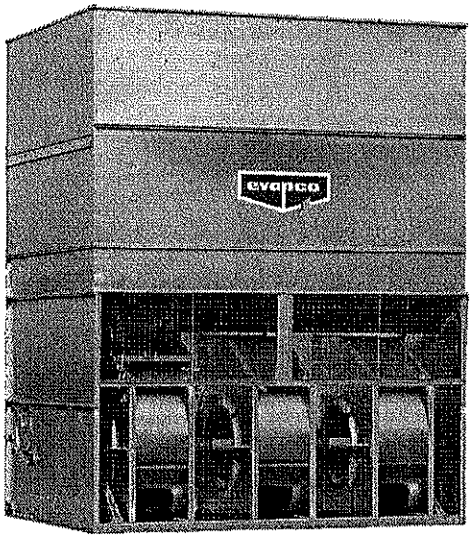
Water Distribution System

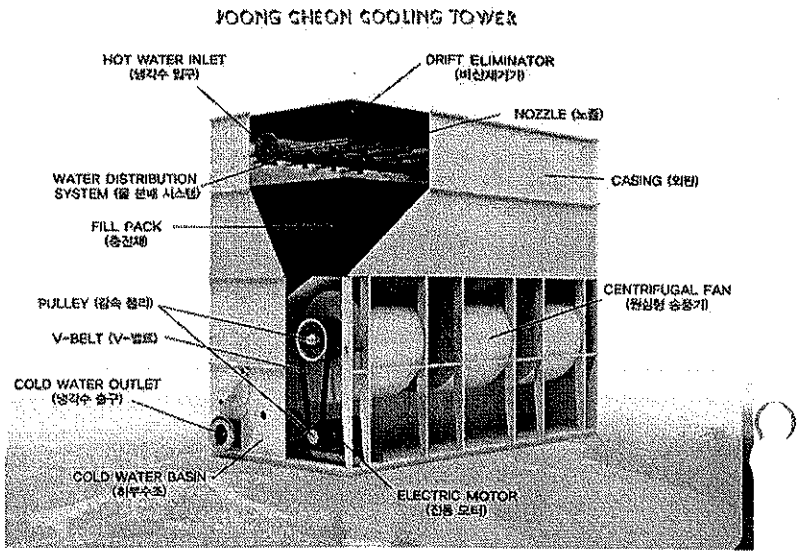
- Counterflow towers use a high pressure spray nozzle hot water distribution system to achieve water coverage of the fill.
- The nozzle spray pattern is sensitive to changes in water flow, and consequent change in nozzle pressure.

Normally used when inlet air intake is restricted and needs high static fans



Forced Draft Counter-flow Tower





Induced Draft Cross-flow Tower

Advantages	Disadvantages
Gravity flow hot water distribution	
• Low pumping head. • Lower first cost pumping systems. • Lower annual energy consumption and operating costs. • Accepts larger variation in water flow without adverse effect on the water distribution pattern (flat plate heat exchanger operation in winter). • Easy maintenance access to distribution nozzles.	• Low pressure head on the distribution pan may encourage orifice clogging and less water breakup at spray nozzle. • Exposure to air in the hot water basin may accelerate algae growth. • Larger footprint.
Horizontal air distribution system	
• The vertical air movement across the fill allows the coldest water to be in contact with the driest air maximizing tower performance.	• The resistance to upward air travel against the falling water results in higher static pressure loss and a greater fan horsepower than in crossflow towers. • The restricted louver area at the base with high velocity of inlet air increases the fan horsepower. • Tendency for uneven distribution of air through the fill with very little movement near the walls and center of the tower. • High inlet velocities are liable to suck airborne trash and dirt into the tower.

Induced Draft Counter-flow Tower

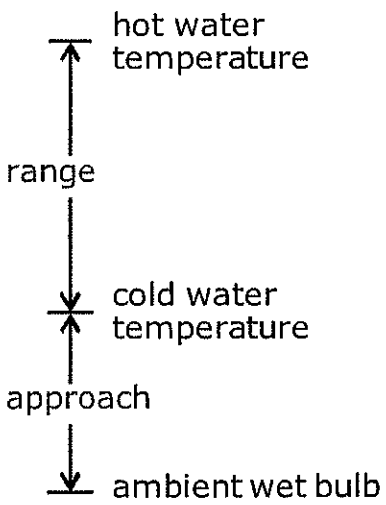
Advantages	Disadvantages
Pressurized spray water distribution system:	
• Increased tower height accommodates longer ranges and closer approaches. • More efficient use of air due to finer droplet size from pressure sprays.	• Increased system pumping head requirements. • Increased energy consumption and operating costs. • Distribution nozzles difficult to inspect and clean. • Requires individual risers for each cell, increasing external piping costs.
Vertical air distribution system:	
• Low static pressure drop. • Reduced drift. • Reduced recirculation. • More air per fan horsepower. • Larger diameter fans can be used so that fewer cells are required for a given capacity. • Lower energy and operating costs.	• Larger louver surface area makes icing more difficult to control.

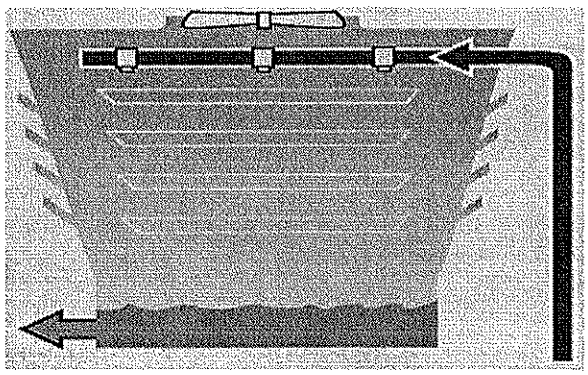
Conclusions and Recommendations

Crossflow cooling towers should be specified when the following criteria and limitations are important:	Counterflow cooling towers should be specified when the following criteria and limitations are important:
• To minimize pump head. • To minimize pumping and piping first costs. • To minimize operating costs. • When condenser water flow variance is expected. • When ease of maintenance is a concern.	• When space (footprint) is restricted. • When pumping is designed for additional pressure drop. • When icing is of extreme concern.

Cooling Tower Performance

Performance Factors





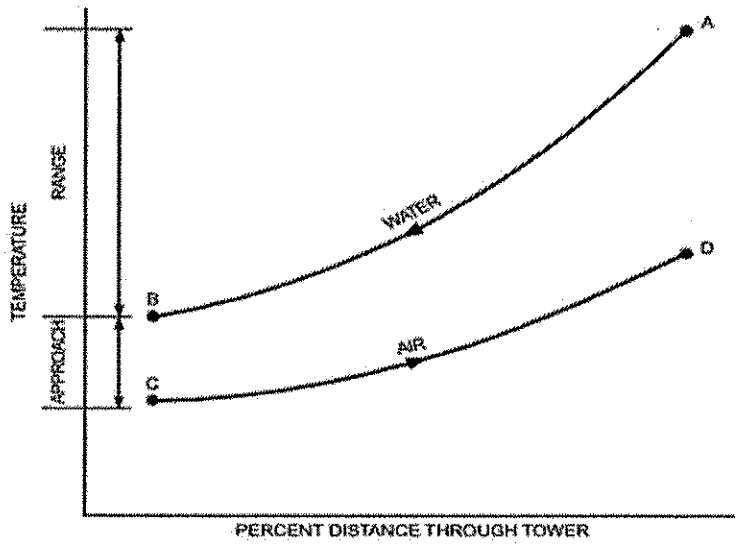
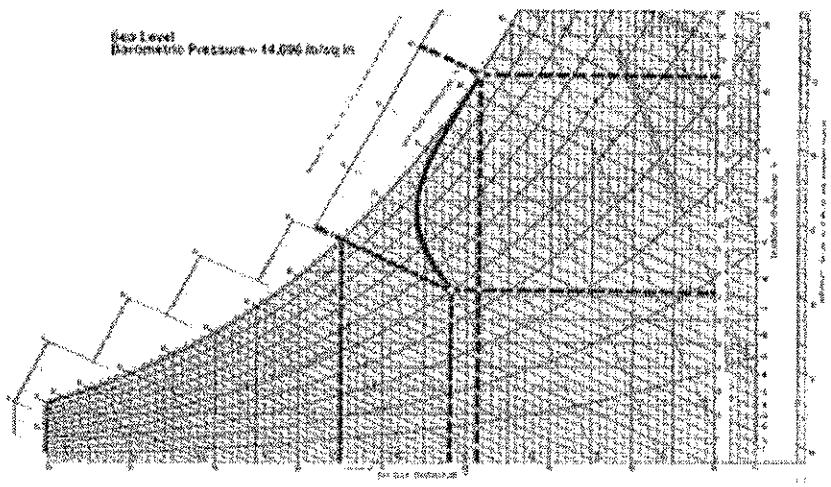
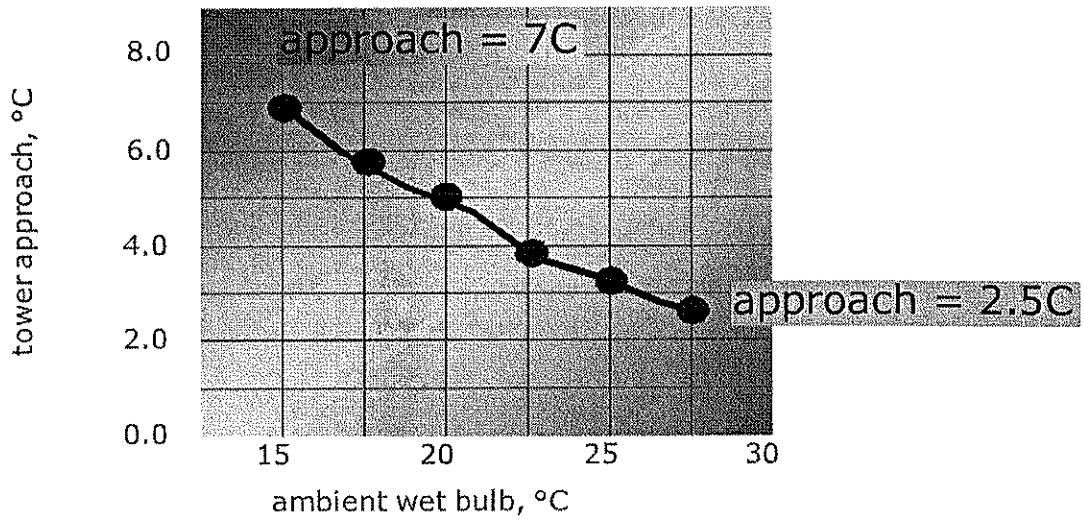


Figure 1. Temperature Relationship Between Water and Air in Counterflow Cooling Tower



The CT air discharge air is typically saturated and at a higher WB and DB compared to the inlet air.
The increase in air enthalpy (approximated by WB) is equal to the heat absorbed from the CW.

Approach and Wet Bulb



Cooling Tower Rating

- CTI – 201: Rating Standard for Open Loop Propeller or Axial Fan Cooling

<u>Typical cooling tower rating condition for Singapore</u>

- Entering water temperature: 35.0C
- Leaving water temperature: 29.5C
- Ambient wet bulb temperature: 27.0C

LAYOUT CONSIDERATIONS

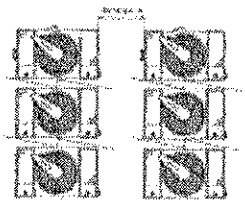


Figure 1

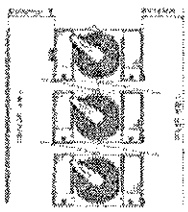


Figure 2

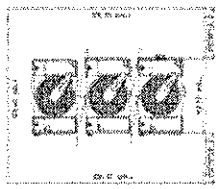


Figure 3

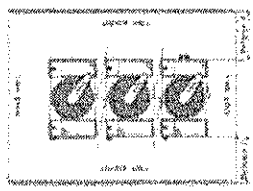


Figure 4

Cell	Figure 1	Figure 2		Figure 3	Figure 4	Figure 5
	Min. Distance Louver To Louver	Min. Distance Air Inlet To Louver Wall	Min. Distance Air Inlet To Solid Wall	Min. Distance For Cooling Tower In Enclosure (Solid Wall)	Min. Distance For Cooling Tower In Enclosure (Louver To Louver Wall)	Min. Distance For Cooling Tower In Enclosure (Louver Wall)
	Distance A	Distance B	Distance C	Distance D	Distance E	Distance F
1 Cell	1.5 Metre	1.5 Metre	1.5 Metre	1.5 Metre	1.5 Metre	1.5 Metre
2 Cells	2.5 Metre	1.5 Metre	2.5 Metre	2.5 Metre	1.5 Metre	1.5 Metre
3 Cells	3.5 Metre	1.5 Metre	3.5 Metre	3.5 Metre	1.5 Metre	1.5 Metre
4 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
5 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
6 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
7 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
8 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
9 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre
10 Cells	5.0 Metre	1.5 Metre	5.0 Metre	5.0 Metre	1.5 Metre	1.5 Metre

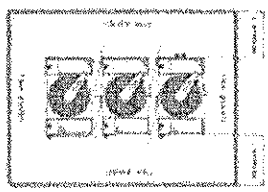


Figure 5

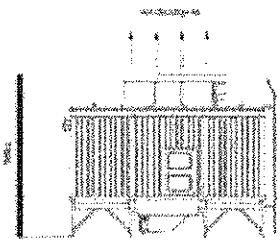


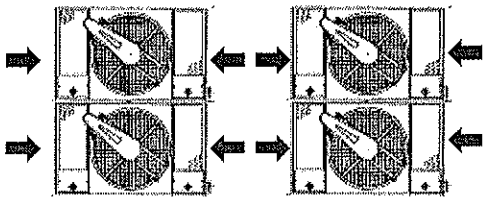
Figure 6

This is only a guide for a particular model of CT.

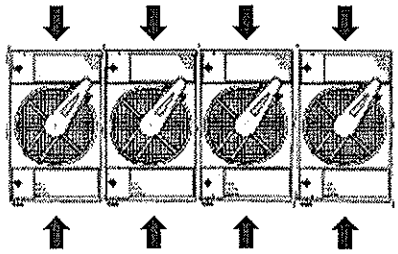
Requirements vary for different brands and models.

Consult OEM for different brands

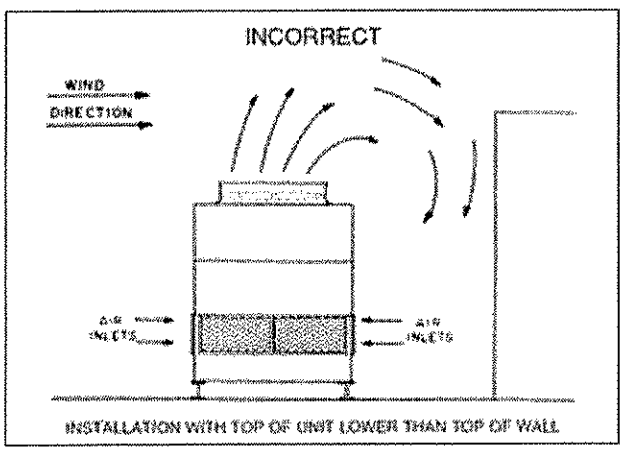
Intake air adjacent to each other

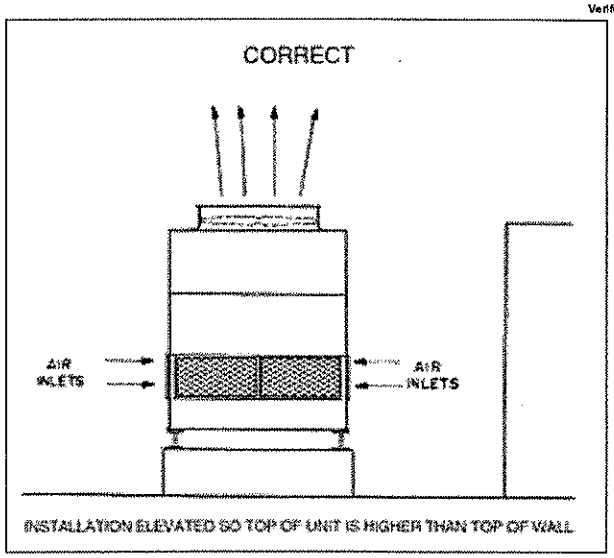


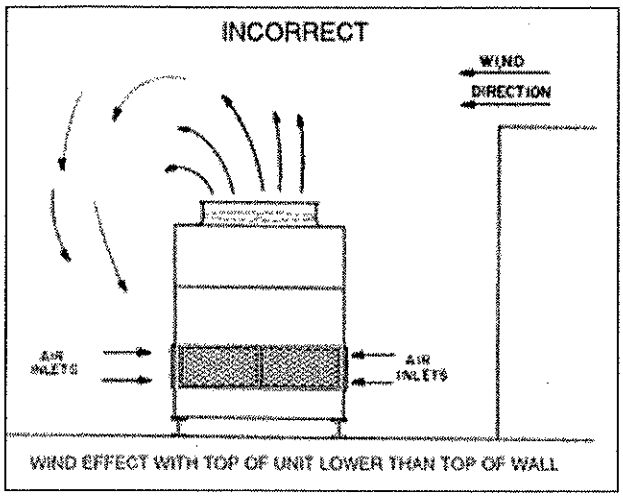
Intake air parallel to each other

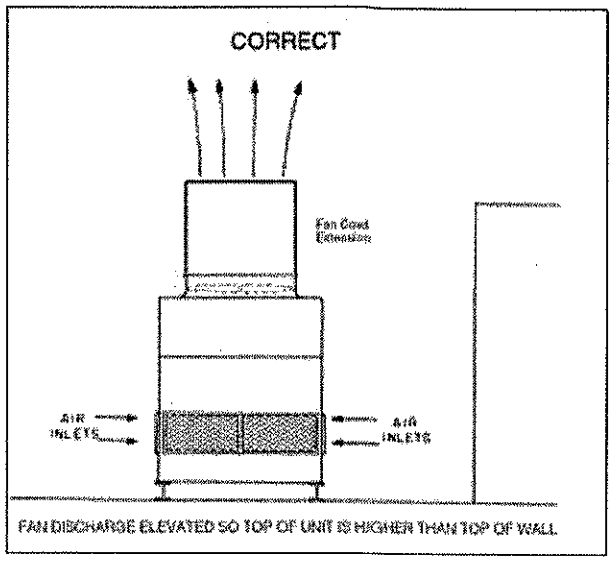


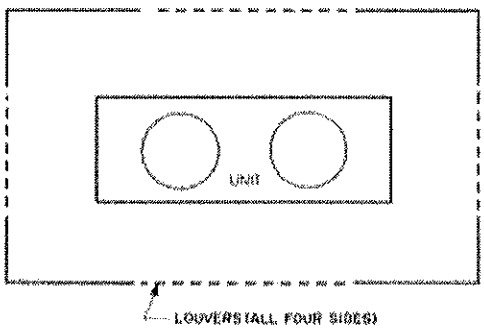
Preferred Layout











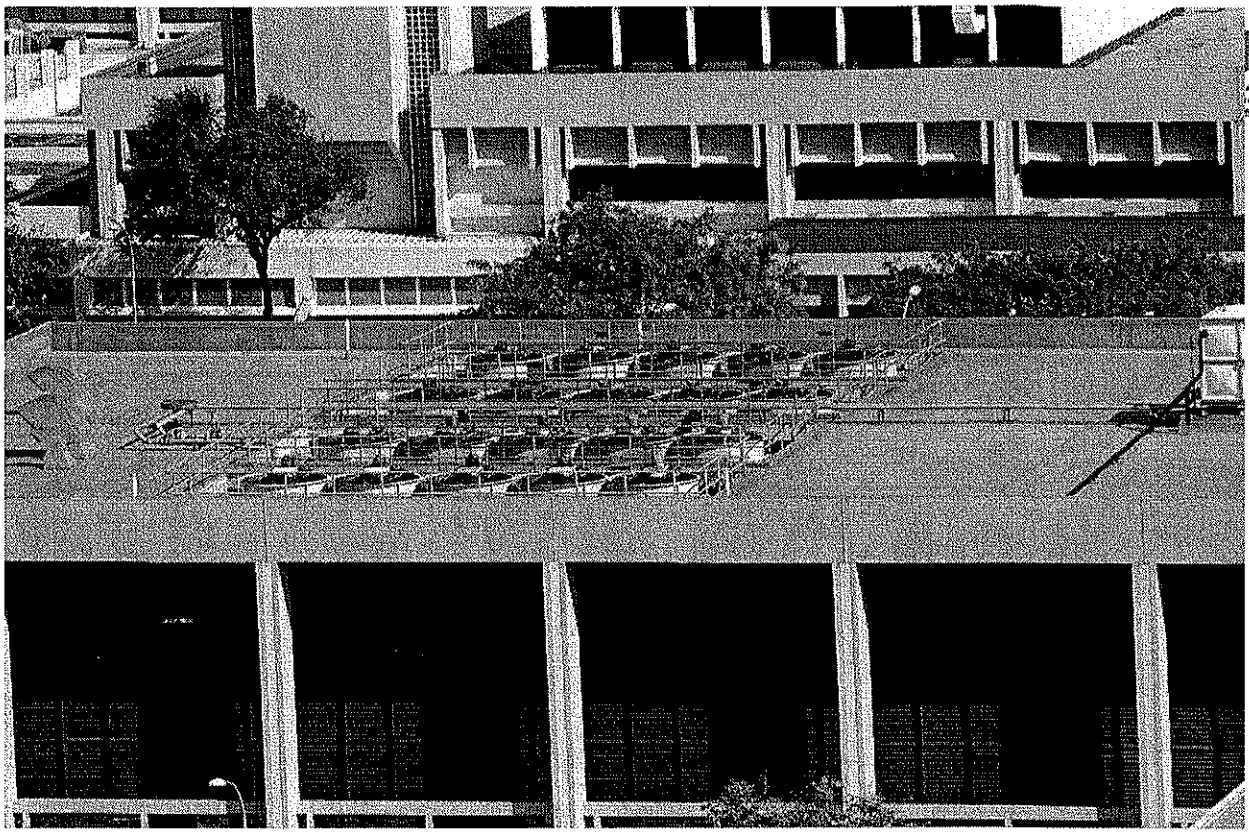
The inlet air will be drawn from the top and through the louvers.
To minimize the potential for recirculation, it is better to draw most of the air through the louvers.
Since the air will follow the path of least resistance, the pressure drop through the louvers will determine how much air is drawn from both areas.
Therefore, it is important that the louvers are designed for minimum pressure drop.
To achieve this goal, the velocity through the louvers should be maintained at or below 600 F.P.M., the louvers should have a minimum of 50% net free area, and the air inlets should face the louvers.



Measurement & Verification Pte Ltd

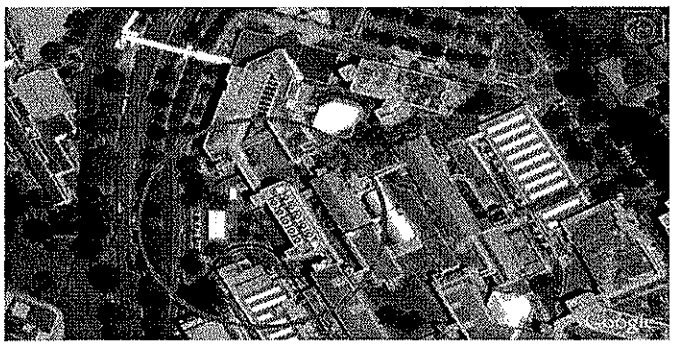
27

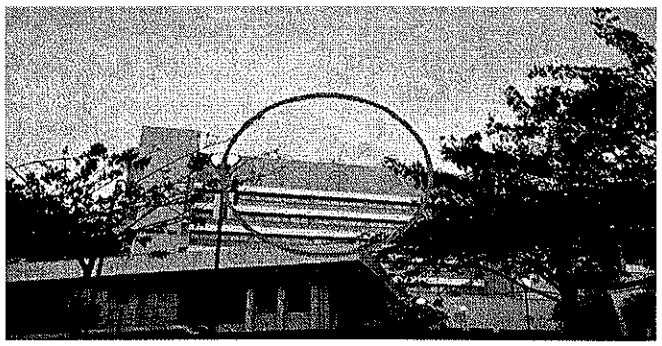




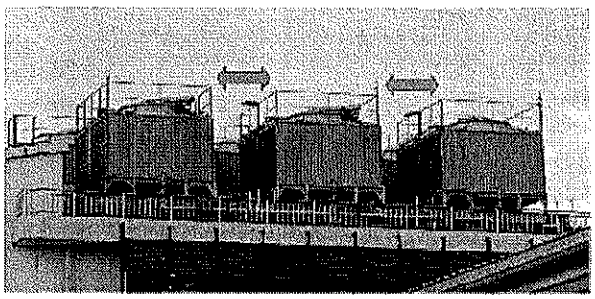
29

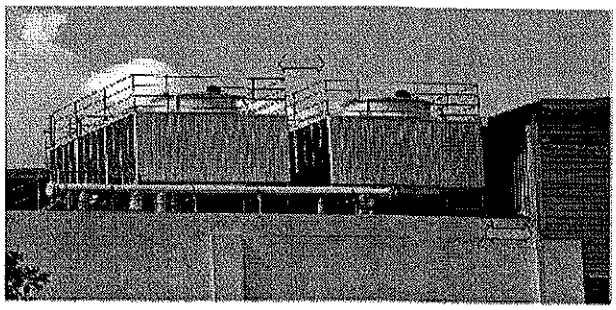
Cooling Tower Layout Considerations

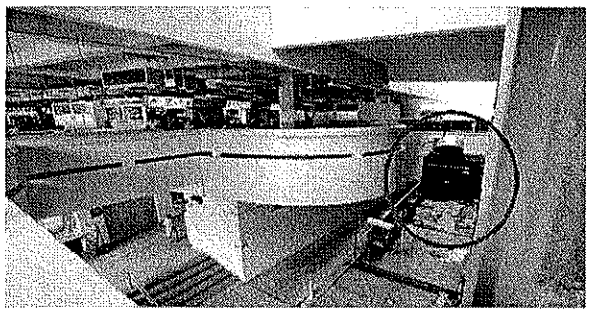


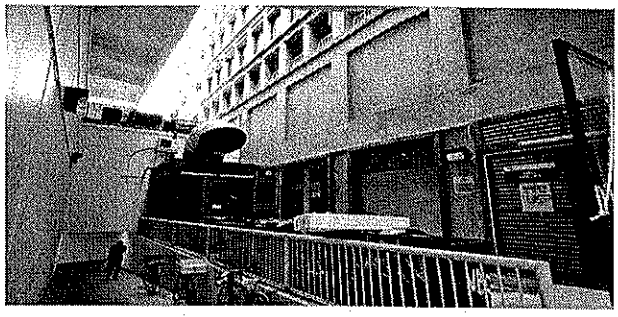


Cooling Tower Layout Considerations









THANK YOU

