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Important Criteria When Considering Cooling Towers for Your DCP

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Important Criteria When Considering Cooling Towers For Your DCP

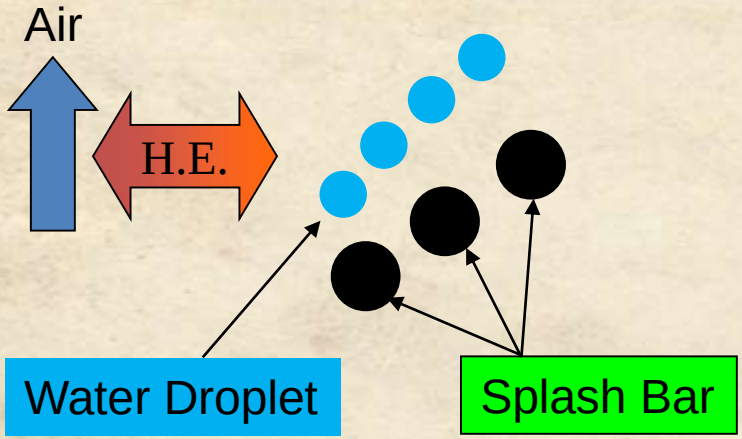
- **Film Fill Types – Materials – Maintenance**
- Cooling Tower Layout
- Thermal Performance Certification (CTI)

Film Fill types – Materials – Maintenance

- **Types of Fill & Selection Criteria**
- Thermal Performance Ratings
- Material and Mechanical Properties
- Fill Life Time and Maintaining Tower Efficiency

Fill Selection Criteria

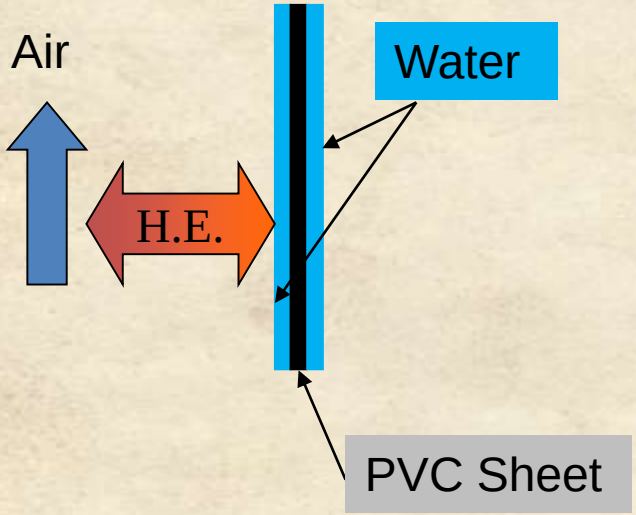
Splash Type



- The water droplets generated by splashing
- Heat exchange between water droplets surface and air

Fill Selection Criteria

Film Type



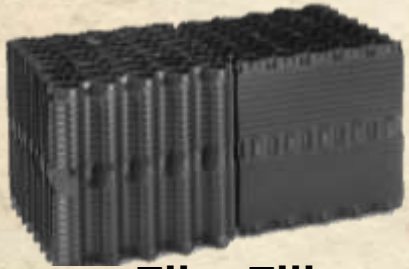
- Heat exchange between water film surface on PVC sheet and the air

Fill Film Selection

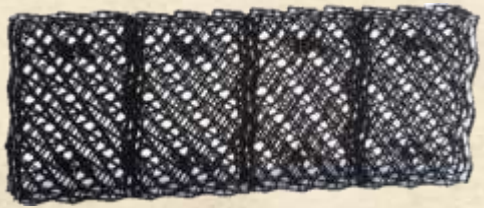
- Fill is a media to create more **water surface** exposed to the air
- Fill increases the time air-water contact by retarding the progress of water

Increased heat transfer

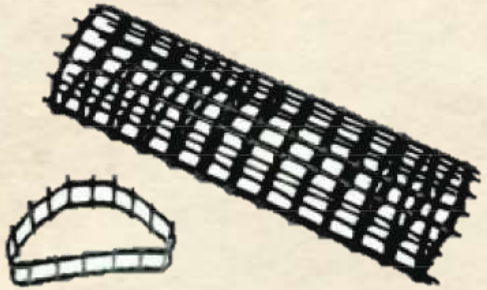
Fill Selection Criteria



Film Fill



Perforated Sheet



Splash Bars

Splash Grids

Water Quality

Fill Selection Criteria

The selection of the FILL TYPE depends on the circulating water characteristics:

- Type of water: sea, TSE, potable water
- Type of industry: power, chemical, paper, steel, DCP ...
- Water availability (concentration factor)
- Type of water treatment

Water Quality

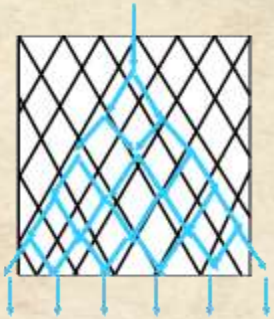
Fill Fouling Directly Related to Total Suspended Solids (TSS) & Biological Activity

- Origin Suspended Solids in the circulating water:
  - TSS of make up water
  - Dust and airborne particles washed by the cooling tower
  - Dispersants used to control the scaling

- Biological activity controlled with biocides injection

TSS maximum concentration for each fill is only valid if the Biological activity is controlled !

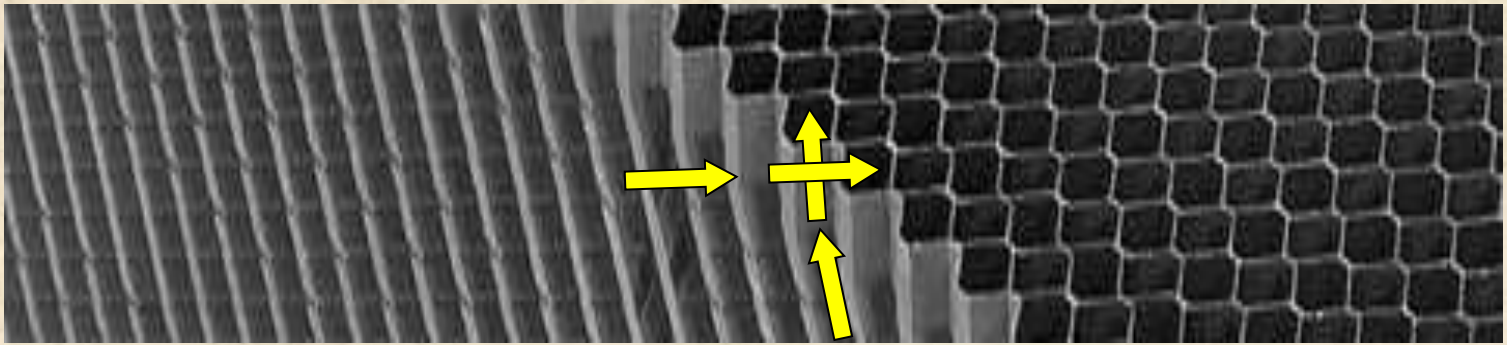
Film Fill Types



Cross-Flutes
High Efficiency

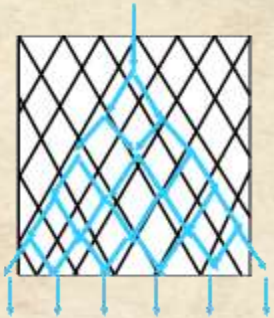
+++

Cross Corrugated Film Fill Type

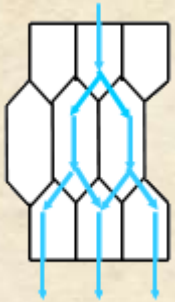


- Cross corrugated flutes require (very) good water quality
- Highest specific heat transfer
- Slow water / long air travel ➔ risk for fouling
- Crossed sheet design = high structural rigidity

Film Fill Types

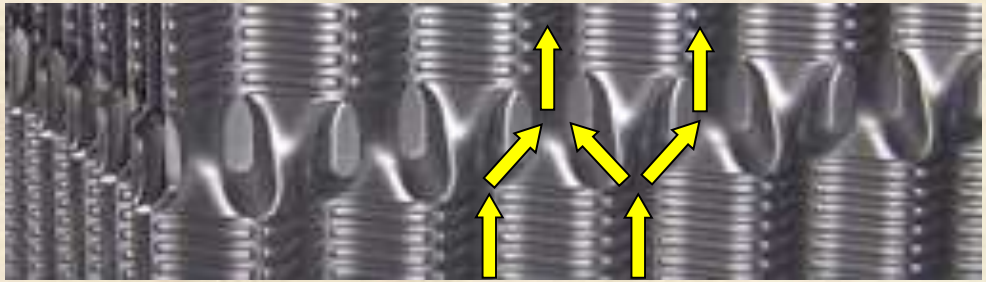


Cross-Flutes
High Efficiency



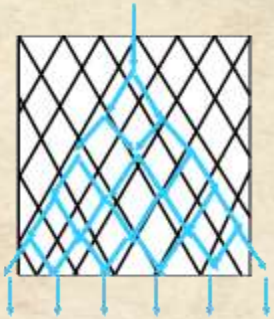
Offset-Flutes
Efficient
Low-Fouling

Vertically Offset Flute Film Fill Type

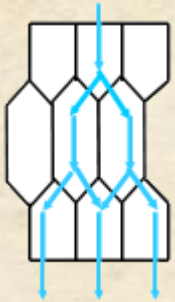


- Offset flutes require good water but more forgiving than cross corrugated
- Highly efficient sheet texture and transitions
- Moderately fast water vs. air travel = low fouling risk
- Lower efficiency compensated by low pressure drop

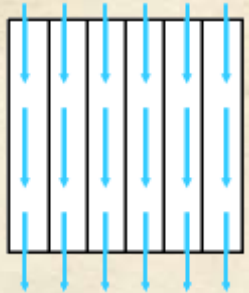
Film Fill Types



Cross-Flutes
High Efficiency



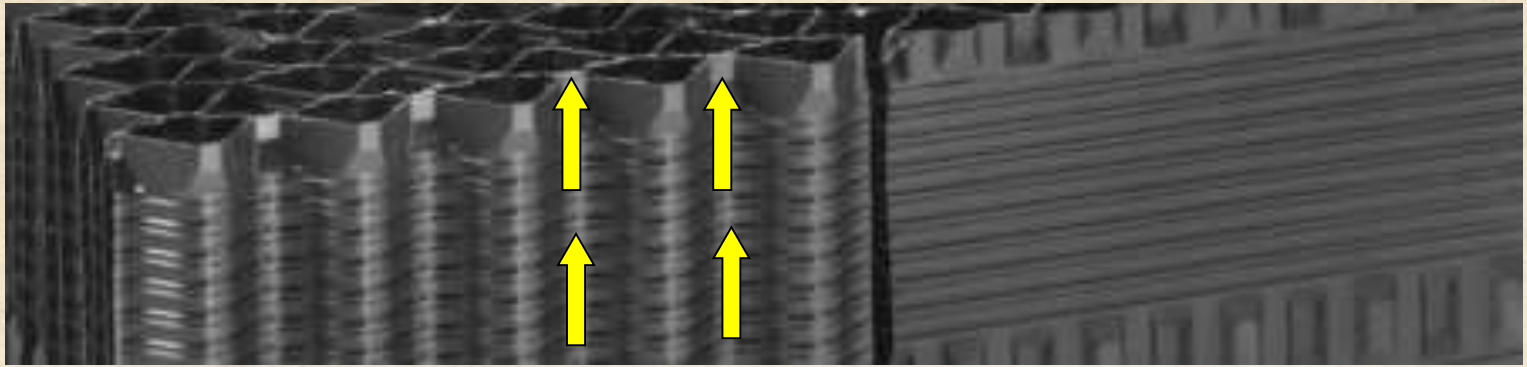
Offset-Flutes
Efficient
Low-Fouling



Vertical-Flutes
Anti-Fouling

+++ ++ +

Vertical Flute Film Fill Type



- Vertical flutes handle severe water quality well with proper bacterial control
- Efficient sheet texture = very low fouling risk
- Fast water / air travel = very low fouling risk
- Very low pressure drop = better than splash

Water Quality Comparison

Biological / Bacteria and Total Suspended Solids

Fill Type	High Performance film fill 12 mm or 19mm Spacing Cross Fluted (EVAPAK®)	Low Fouling film fill 25 mm Spacing Vertical Fluted (TechClean™)	Anti-fouling film fill 19mm Vertical Flow (VertiClean™)	Splash Fill Bars / Grids (Opti-Bar™ Arch-Bar™ Opti-Grid™)
TTS (ppm)	**<25**	**<50**	**<100**	**>100**
Bacteria Count (ppm)	<10,000	<100,000	<1,000,000	>1,000,000
Bio & Scale Control	Required	Required	Required	Lower to none

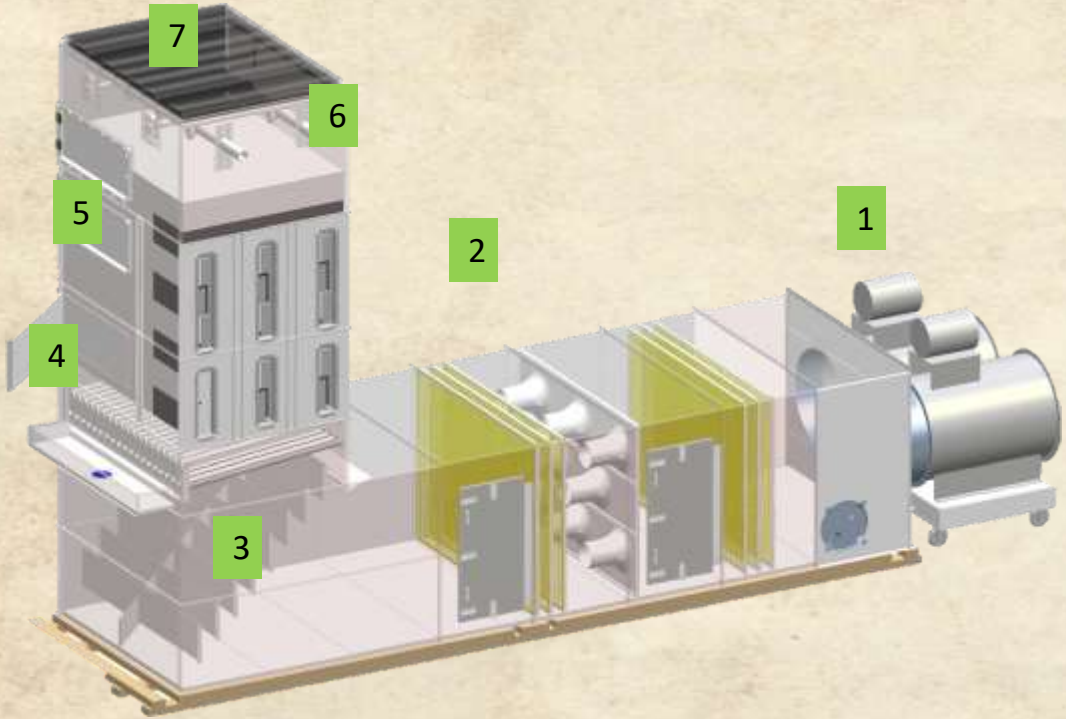
Note: Fill spacing function of TDS

Film Fill types – Materials – Maintenance

- Types of Fill & Selection Criteria
- **Thermal Performance Ratings**
- Material and Mechanical Properties
- Fill Life Time and Maintaining Tower Efficiency

Thermal Performance Ratings

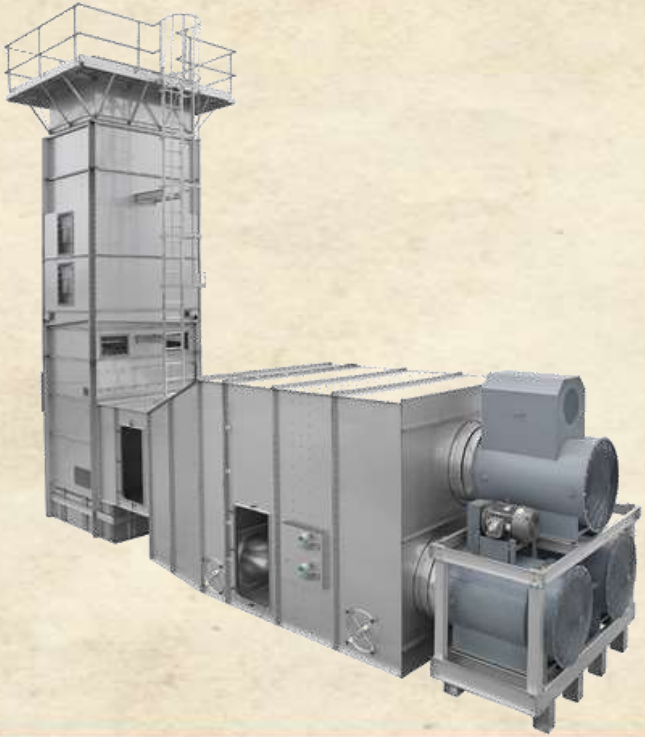
Counterflow Film Fill and Spray Test Cell



1. Forced draft fans
2. Airflow nozzle wall to measure volumetric airflow
3. Turning vanes
4. Cold water collecting troughs and mixing box
5. Counterflow fill test section
6. Hot water distribution pipes and spray nozzles
7. Drift eliminators

Thermal Performance Ratings

Counterflow Film Fill and Spray Test Cell



Thermal Performance Ratings

- KaV/L
- ΔP

Production testing:

- Film fills
- Splash fills
- Drift eliminators
- Spray nozzles

Air rate:

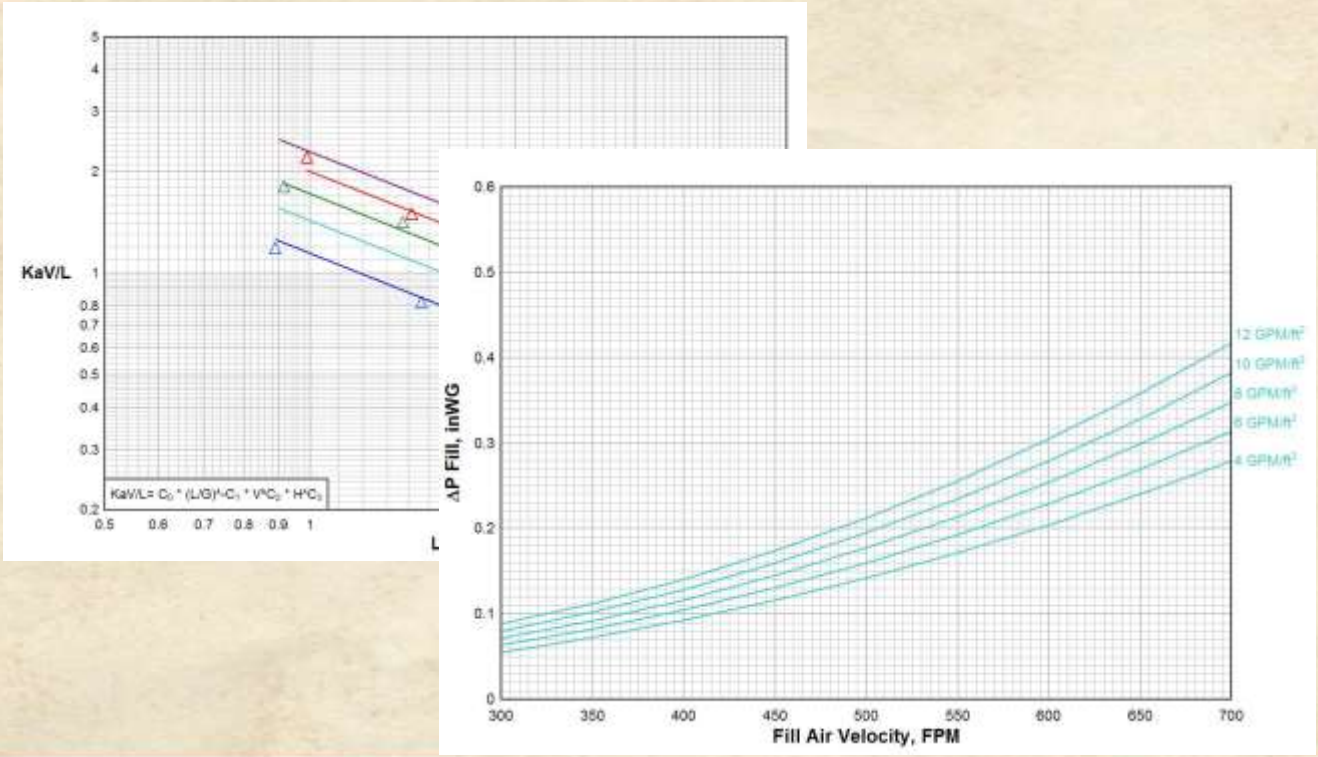
1.5 → 5.0 m/s (300-1000 FPM)

Water rate:

45 → 160 m³/h (200-700 GPM)

Thermal Performance Ratings

Fill Data



Thermal Performance Ratings

Thermal Rating Sheet (CTI Summary)

Rated Using Evap Suite (Version: Debug v 07.01.2015)

Project Name: 40wide Stadium
Customer Name:
Location:
Proposal Number:
Selection ID: 31 | 3C 39x38 2D TCI ATC |

Date Rated: 7/1/2015
Date Printed: 7/7/2015

Contact Name: Andrew T Cell
Contact Phone: 410-799-2690

Selection Type:

Draft Type	Induced Draft
Flow Type	Counterflow
Operation Mode	Normal
Wet / Dry Mode	Wet Only
Sizing For: Motor* - Given: HWT, CWT, WBT, WFlow	

Components

Louver Model	Wide
Fill Model	TechClean 312 (11½)
Spray Nozzle Model	EvapJet II
Drift Eliminator Model	DriRite30
Inlet Guides	No

Geometric Conditions:

Tower Elevation	49 ft	15 m
Cell Quantity	3	
Cell Length	39.00 ft	11.582 m
Cell Width	38.00 ft	11.582 m
Quantity Fans Per Cell	1	
Basin Wall Offset	0.50 ft	0.152 m
Air Inlet Arrangement	4: 2 Air Inlets (NS)	

Thermal Results

Predicted HWT	109.04 °F	42.80 °C
Predicted Range	14.04 °F	7.80 °C
Predicted CWT	95.00 °F	35.00 °C
Predicted Approach	0.40 °F	0.00 °C
Predicted Entering WBT	89.60 °F	32.00 °C

Geometric Heights

Air Inlet Height (TOC)	14.00 ft	4.267 m
Fill Air Travel	6.00 ft	1.828 m
Heater Center Line (Est)	22.50 ft	6.858 m
Pumphead (EM)	26.50 ft	8.077 m
Plenum Height	5.23 ft	1.596 m
Fan Deck Height	30.00 ft	9.144 m
Fan Stack Height	10.00 ft	3.048 m
Total Height	40.00 ft	12.192 m

Water Side Results

Input Water Flow Rate	35,400 GPM	8,046.97 m3/h
Predicted Water Flow	36,460 GPM	8,288.36 m3/h
Predicted Tower Capacity	103.0 %	
Water TDS	---- PPM	
Evaporation	1.39 %	
Evaporation Rate	498 GPM	110.76 m3/h

Fan Information

Fan Manufacturer	Other	
Fan Type	[Fan Type]	
Fan Model	----	
Fan Diameter	26.00 ft	7.925 m
Fan Blades	----	
Fan Blade Pitch	----°	
Fan Static Efficiency	68.8 %	
Fan Total Efficiency	60.0 %	

Airflow

Airflow Per Fan	901,415 CFM	425.42 m3/s

Air Velocities

Air Inlet (Eff - Gross)	821 ft/min	4.170 m/s
Fill (Net)	646 ft/min	3.281 m/s
Drift Eliminator	658 ft/min	3.343 m/s
Fan Stack (Net)	1597 ft/min	8.113 m/s

Drive Information

Motor Speed	1,775 RPM	
Drive Model	1712	
Drive Ratio (Nom/Actual)	12:1	
Fan Speed (Tip)	11,684 ft/min	60.37 m/s
Fan Speed (RPM)	145.49 RPM	

System Pressures

Fan Static Pressure	1.032 inWg	257.16 Pa
VP Fan	0.171 inWg	42.57 Pa
Fan Total Pressure	1.203 inWg	299.73 Pa

Power Consumption

Predicted Fan P. (AMS)	222.66 HP	166.03 kW

[Warnings] Fill Outside Test Range: Fill AT > 1.825 m.

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Phone: 913-322-5165
Website: www.evaptech.com
evaptech
EvapTech Asia Pacific Sdn Bhd
MALAYSIA
Phone: 011 603 8070 7255

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Thermal Performance Ratings

- Field data analysis
- Competitive analysis

- KaV/L
- ΔP

Film Fill types – Materials – Maintenance

- Types of Fill & Selection Criteria
- Thermal Performance Ratings
- **Material and Mechanical Properties**
- Fill Life Time and Maintaining Tower Efficiency

Cooling Tower Heat Exchange Surface

CTI STD – 136 : Thermoplastic Materials Used for Film Fill, Splash Fill, Louvers and Drift Eliminators

- This CTI specification covers the most common fills, splash fills, louvers, drift eliminators, nozzles, and other small components for use in standard properties, burning properties, and recommended testing procedures employed to determine the defined values, whether processed from virgin or reground material.

- Revised June 2010

ASTM E 84

ASTM E 84 tests for flame spread rating (FSR).

- Red oak flooring has FSR of 100
- Fiber cement board has a FSR of 0

Historical number Flame Spread Rating PVC Fills was 25.

Today : material with Flame Spread Rating of 5

Film Fill Material Thickness & UV Protection

- Material thickness & UV protection determines life time of the fill

- Specify the fill material thickness “before” and “after forming” !

  The forming process thins the material and

  15 mills PVC fill before forming (can) become **10 mills** after forming !

Remark

How we know that specified numbers and qualifications are valid for the materials supplied ?

Ask specific test reports

Material and Mechanical Properties

Materials

PVC fill

- High strength (CTI STD 136)
- Extremely durable
- Self - extinguishing
- Surface wets – out well
- Can be glued in bundles

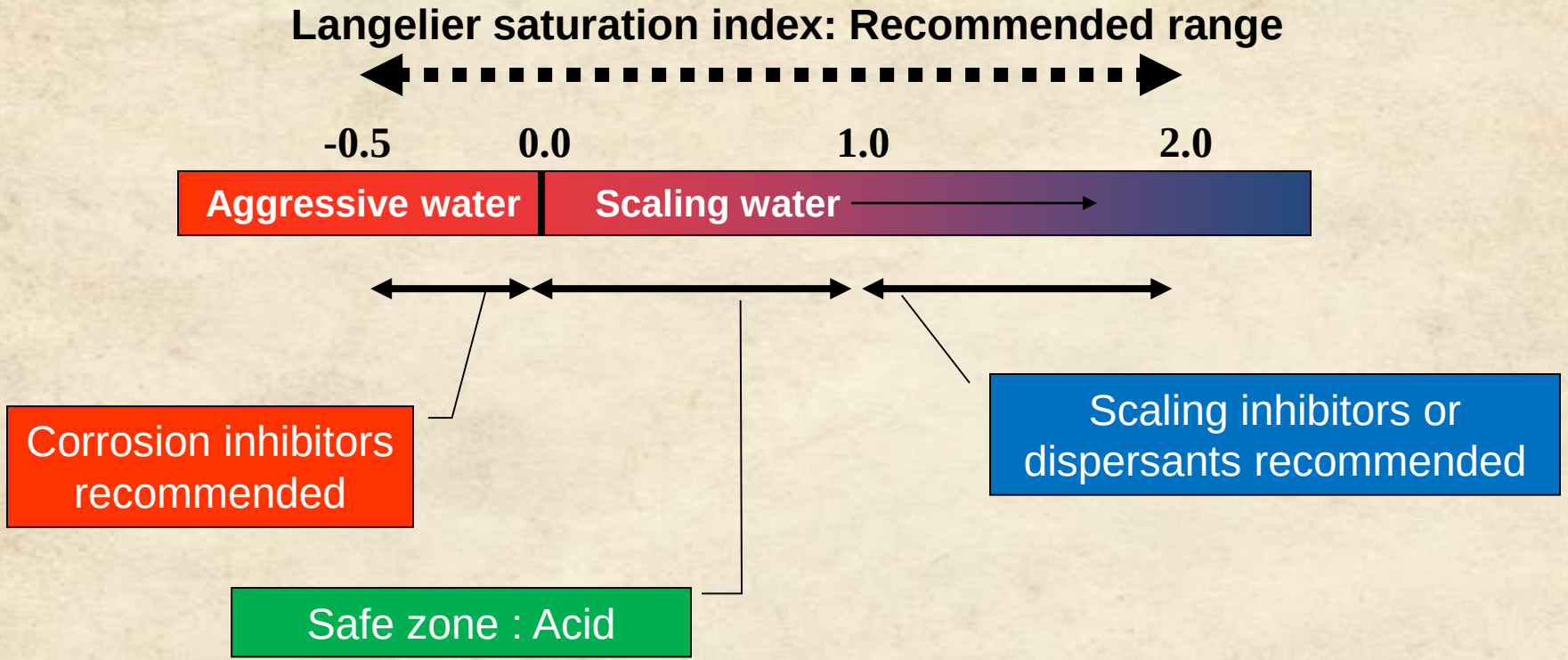
PP fill

- Durable but high creep rate, **need 50 % thicker than PVC**
- **Very Flammable**
- Poor wetting characteristics
- Cannot solvent bond

Film Fill types – Materials – Maintenance

- Types of Fill & Selection Criteria
- Thermal Performance Ratings
- Material and Mechanical Properties
- **Fill Life Time and Maintaining Tower Efficiency**

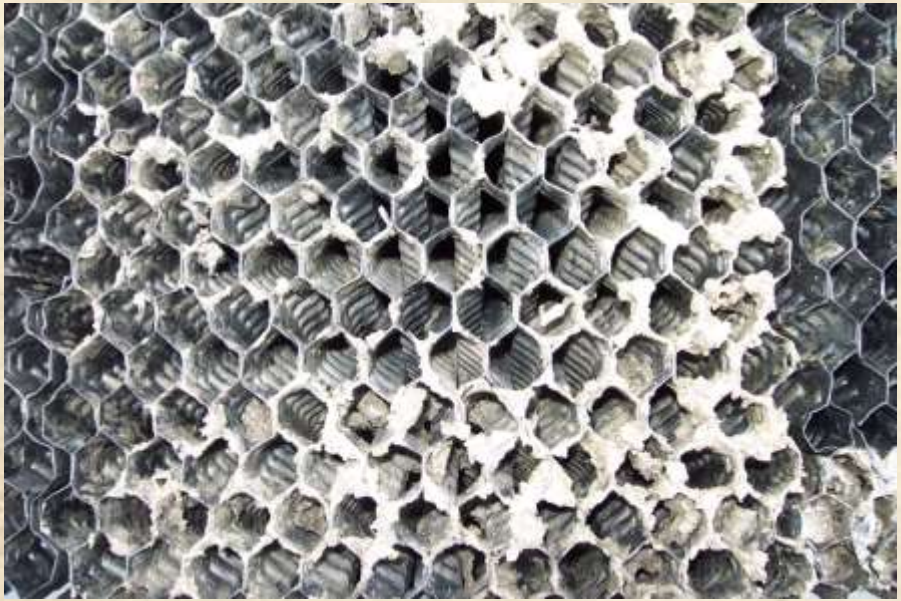
Water Treatment: Scaling



Typical : Limit pH at 8.5-9 maximum

Fill Life Time and Maintaining Tower Efficiency

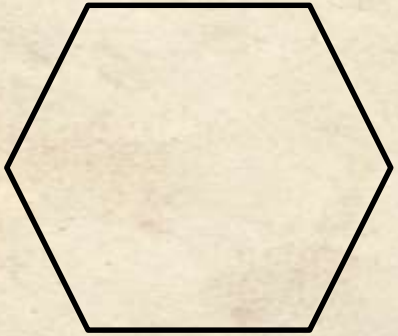
Scale Build-Up on PVC Fill Sheets



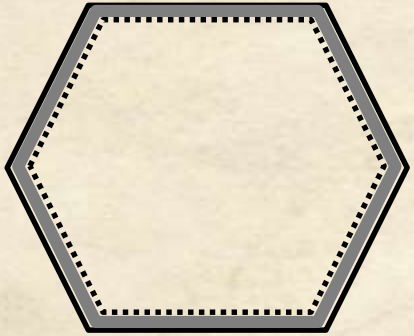
- Maintenance :
  Assure fill remains in good condition
- Water treatment important to control scale build-up

Fill Life Time and Maintaining Tower Efficiency

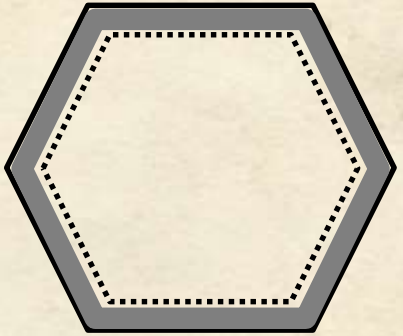
Effect of Fouling on Fill & Cooling Tower Performance



Clean Fill
(48 kg/m³)



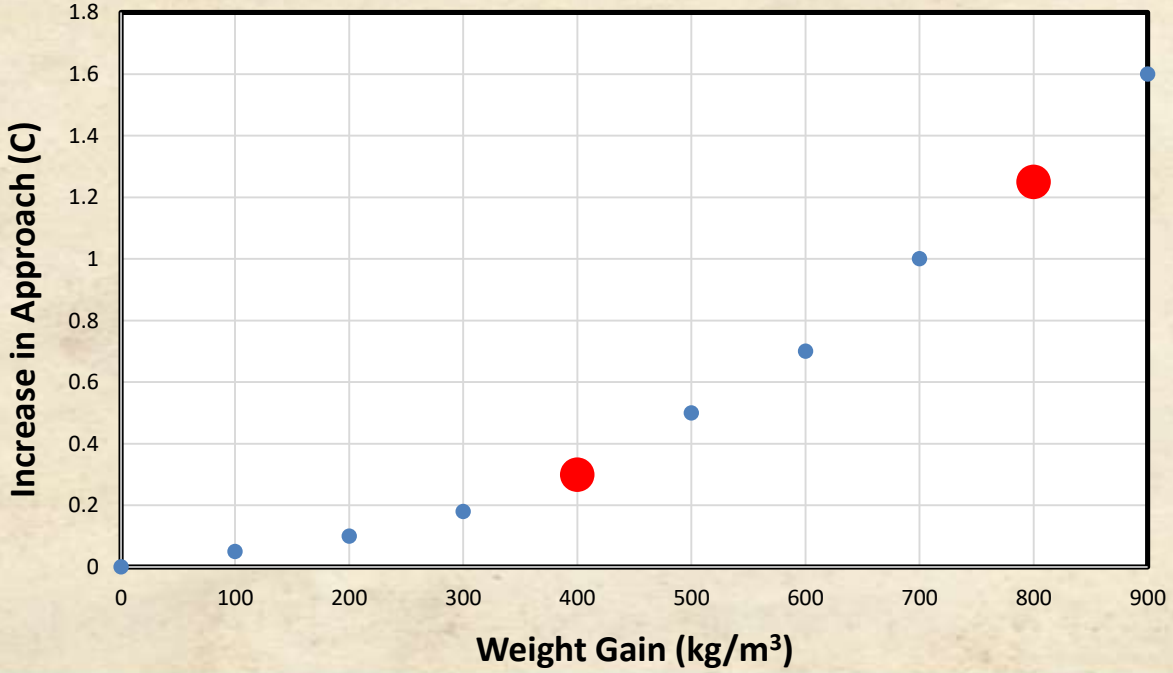
1.6 mm Fouling
(448 kg/m³)



3,2 mm Fouling
(848 kg/m³)

Fill Life Time and Maintaining Tower Efficiency

Estimate of Performance Loss vs. Fouling



Important Criteria When Considering Cooling Towers For Your DCP

- Film Fill Types – Materials – Maintenance
- **Cooling Tower Layout**
- Thermal Performance Certification (CTI)

Cooling Tower Layout

- Arrangement
- Type of Enclosures
- Influence on Thermal Performance
- Clearance
- Type of Influence

Arrangement

Single Row

Arrangement

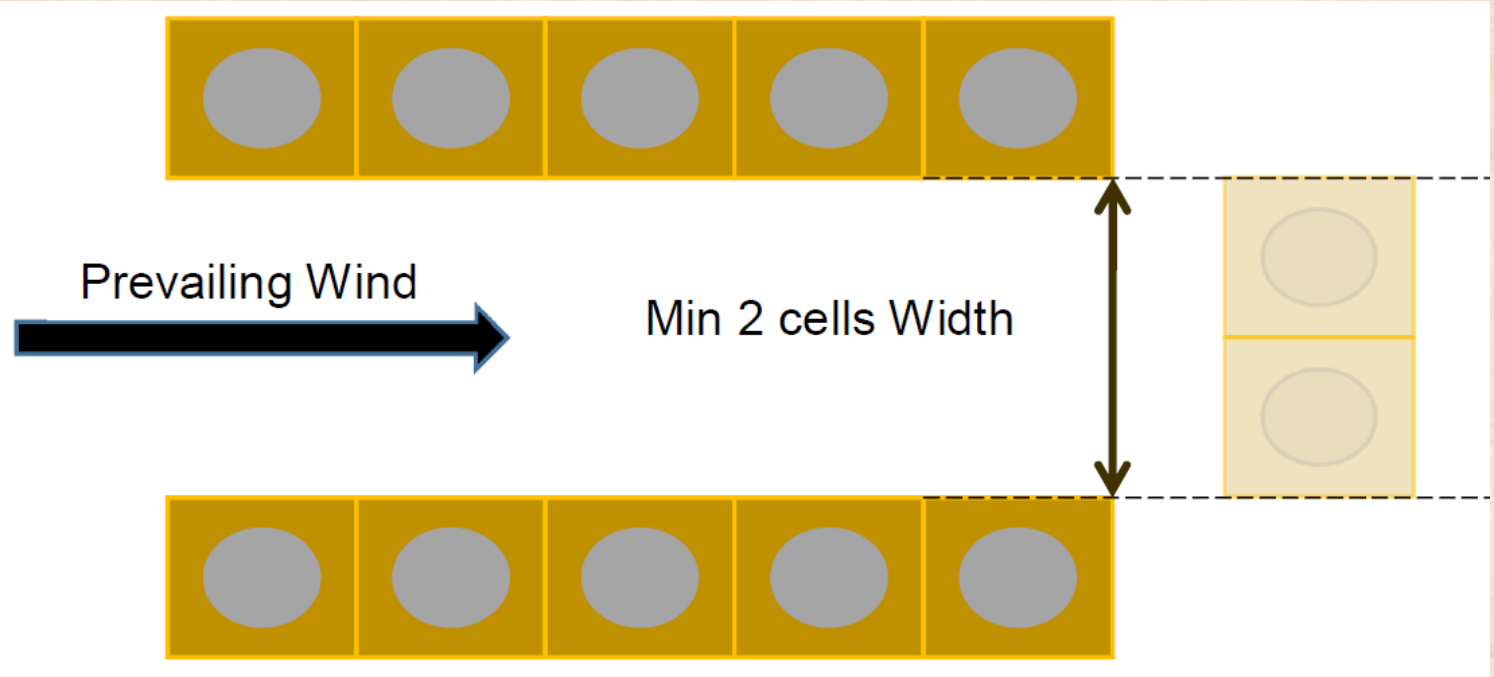
Back to Back (Double Row)

Arrangement

Two Rows – Not Ideal for Recirculation!

Arrangement

Two Rows – Not Ideal for Recirculation!



Arrangement

Stairway ➔ Space Required!

Type of Enclosures

Free Field Installation

Type of Enclosures

Solid Walls Enclosures

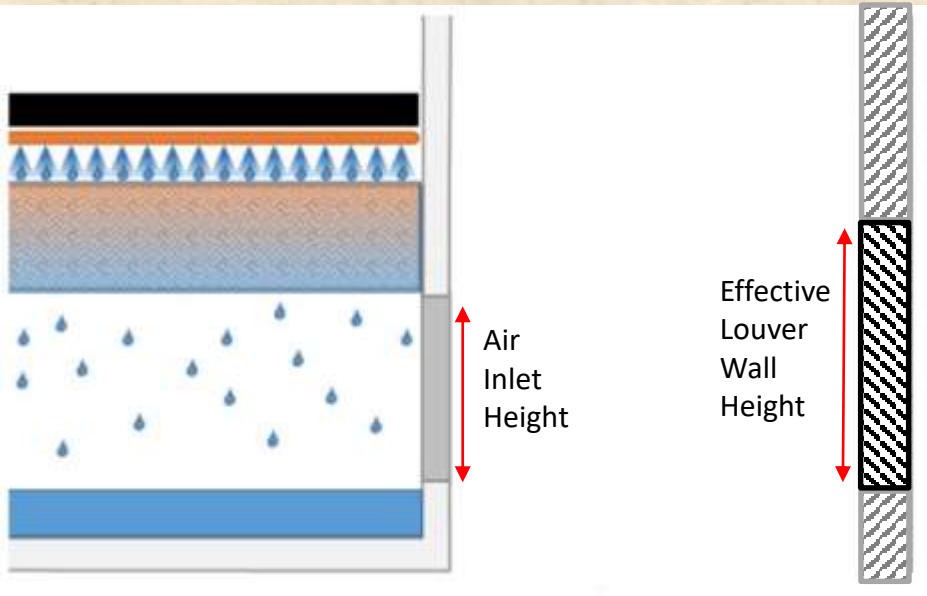
Type of Enclosures

Louvered Walls Enclosures

- % Free open area louvers
- Pressure drop through louvers
- Orientation

Type of Enclosures

Louvered Walls



Effective louver wall height

=

1.2 x air inlet height

Type of Enclosures

Louvered Walls

- Air flow takes the path of least resistance.
- Equilibrium Point : vertical downward air flow ⟷ air flow through louvers

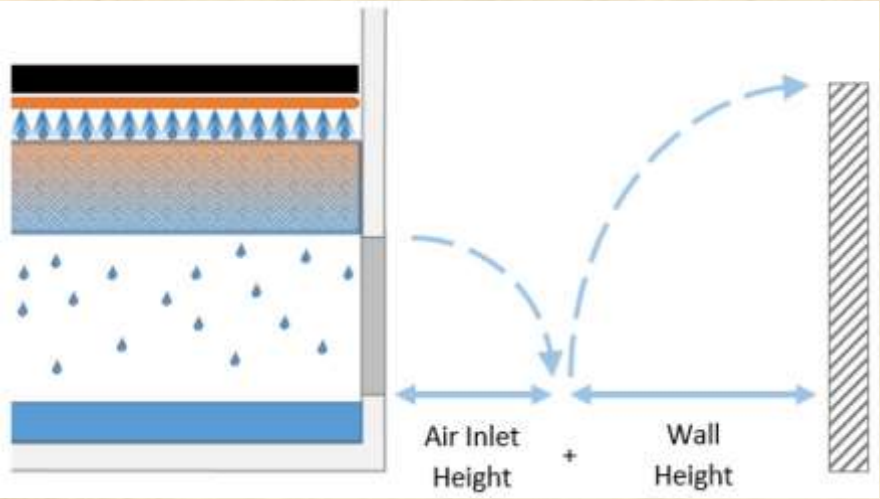
Wall Type	Louver	Solid
Net Vertical Air Velocity ≤	600 FPM	400 FPM
Net Louver Air Velocity ≤	500 FPM	N/A

Influence on Thermal Performance

- Net free open area
- Air flow obstruction
  - Enclosure structural framing
  - Piping
  - Walkways
- Clearance

Clearance

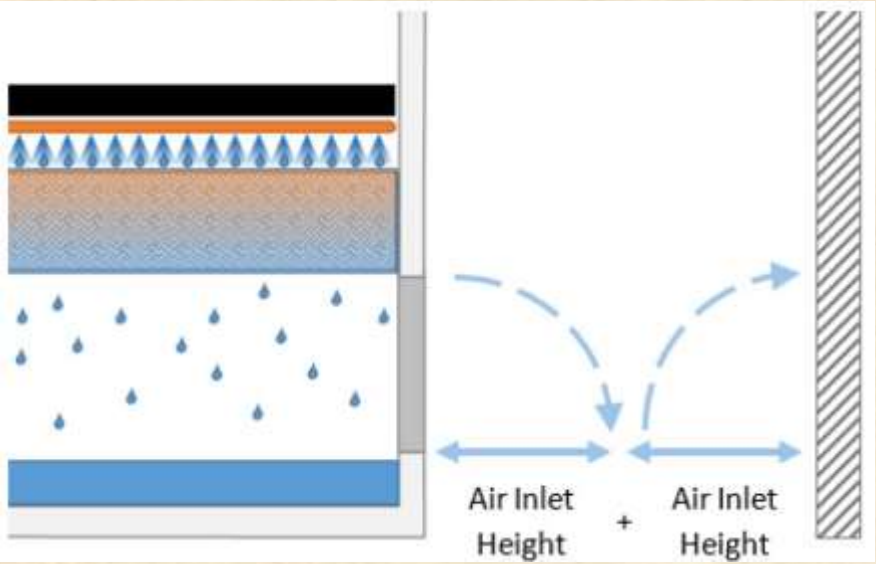
Case 1



- Minimal impact
- No correction required

Clearance

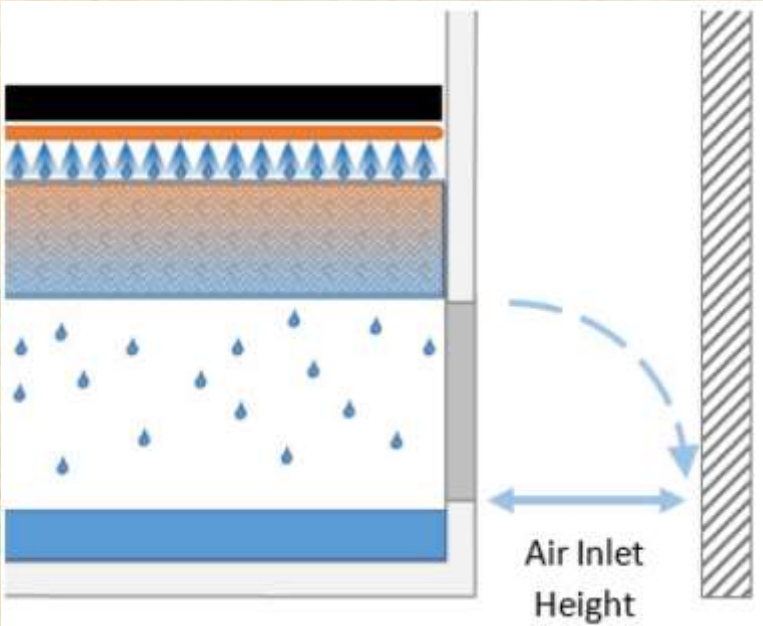
Case 2



- 2 x air inlet height < clearance < air inlet height + wall height
- Add 5 Pa (0.02 in WG)
- Risk for recirculation!

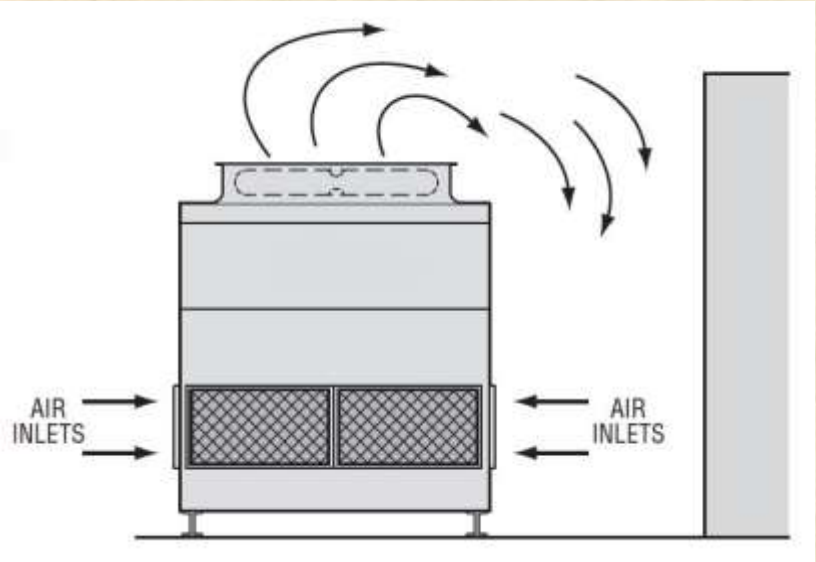
Clearance

Case 3



- 1 x air inlet height < clearance < 2 x air inlet height
- Add 10 Pa (0.04 in WG)
- High risk for recirculation!

Type of Influence



- Increased pressure drop
- Mal-distribution of air
  - Increased static pressure
  - Hot water bypass
- Recirculation
  - Height of enclosure
  - Solid or louvered wall
  - Clearance

Layout

IF YOU OBSTRUCT THE AIR TO THE COOLING TOWER

THE COOLING TOWER DESIGN / THERMAL PERFORMANCE WILL BE AFFECTED

Important Criteria When Considering Cooling Towers For Your DCP

- Film Fill Types – Materials – Maintenance
- Cooling Tower Layout
- **Thermal Performance Certification (CTI)**

CTI Standards

- STD-105

  Code/Procedure for CT Thermal Performance Testing on Site

- STD-201

  Certification Program: Thermal Performance of **Packaged CT's**

- STD-202

  Voluntary Program for **Custom/Field Erected** Cooling Towers

CTI STD-105

- Test Conditions: max. variations
  - Wet-bulb: +/- 8.5°C (15°F)
  - Range: +/- 20%
  - Water flow: +/- 10%

- Instrumentation
- Measurements
- Evaluation of results

CTI STD-201

- Certification Scope:
  - Wet-bulb: 12.8°C to 32.2°C (55°F to 90°F)
  - Range: ≥ 2.2°C (4°F)
  - Approach: ≥ 2.8°C (5°F)
  - Inlet T: ≤ 51.7°C (125°F)

- Standard models
- Accessories

CTI STD-202

NEW

- Participants allow CTI to publish thermal performance test results
- Field test must be executed by CTI licensed test agency
- <u>Participants:</u>
  - Composite Cooling Solutions, L.P. (CCS)
  - Evaptech Inc. (Evapco Inc.)
  - SPX Cooling Technologies, Inc (Marley)

CTI STD-202

CCSolutions® Composite Cooling Solutions, L.P.

evaptech EvapTech, Inc A wholly owned subsidiary of Evapco, Inc.

MARLEY®

Participating Manufacturer	Composite Cooling Solutions, L.P.	EvapTech, Inc.	SPX Cooling Technologies	All Multi-Agency Acceptance Tests for the previous year*
Testing during the Period:	8/21/2013 to 08/16/2016	10/26/2013 to 10/18/2016	05/20/2015 to 08/30/2016	2015
Percentage of tests at or above 100% Capability	N.A.	100	60	62
Percentage of tests at or above 95% Capability	N.A.	100	100	82
Average Capability of tests below 95% Capability	N.A.	None	None	89.4
Average Water Flow Rate	N.A.	74,059	108,282	58,583

N.A. = At the time of this publication the minimum number of CTI licensed tests required to publish results by STD-202 have not been performed.

Benefits for Owners/Operators

- Performance tests demonstrate the actual thermal performance
- Lower outlet water temperature ➔ chiller efficiency increases
- More efficient DCP ➔ lower energy consumption

Innovations for LIFE

- Taking
- Quality & Service
- to a Higher Level