Cooling Tower Basins

Design Considerations and Applications

February 20, 2014
Agenda

• Basins? Really?
• Industry Standards
• Design Considerations
  – Geometry
  – Materials
  – Hydraulics & Flow
  – Pump Intakes
  – Maintenance
  – Basin Coatings
  – Acoustics
• Design Examples
Why Should I Care?

• Typical Basin...

• Provide for:
  – Water retention
  – Tower support
  – Solids collection
  – Maintenance

• Vendor guidance:
  – Basin design by others...
  – Hydraulic design of basin by others...
Industry Standards

- CTI Standards: 47; address basin design
- CTI Technical Papers: >1000; address basin design
  - TP10-26: Cooling Tower Basin Leakage Assessment & Mitigation
  - TP02-05: Concrete Basics, Materials, Selection in Design and Repair
  - TP71-07: Design of Concrete Basins for Cooling Towers
- ANSI/HI 9.8: Pump Intake Design - Geometry
- The rest is up to you...
Design Considerations

• Geometry
  – Cooling tower size/layout
  – Site & available space
  – Water patterns with fan operation
  – Pump types & location
  – Storage volume
Design Considerations

• **Materials - Concrete**
  – Durability
  – Integrity

• **3 Most Important Concrete Factors**
  – Quality Materials
  – Quality Design/Detailing
  – Quality Installation

• **How does concrete fail?**
  – Corrosion of Embedded Materials
  – Freeze-Thaw
  – Aggressive Chemical Exposure
  – Chemical Reactions of Aggregates
Design Considerations

- Concrete Design
  - Mixtures
  - Control joints
  - Waterstops
  - Pour temperatures
  - Embedded reinforcement

- Subsurface quality
- Structural loading
- Leakage
Design Considerations

• Concrete Specifications
  – Air entraining admixture for freeze thaw resistance
  – To reduce permeability, Fly Ash or Silica Fume

• Reinforcing Steel
  – Epoxy Coated A615 reinforcement - $2,200/ton
  – Hot Dip Galvanized A615 reinforcement - $2,540/ton
  – MMFX reinforcement - $2,500/ton (fewer tons req’d)
  – Stainless Steel - $4,800/ton

• Concrete Cover
  – Concrete cast against earth – 3”
  – Water Retaining Structures – 2”
Design Considerations

• Specific phenomena that can adversely affect pump performance:
  – Submerged vortices
  – Free-surface vortices
  – Excessive pre-swirl entering the pump
  – Entrained air or gas bubbles
Design Considerations

- Basin Hydraulics & Flow: CTI TP71-07
  - Limit water velocity at basin outlet (to pumps) to 1 to 2 FPS maximum
  - Use 6-inch tall mud sill to trap sludge that drops out of suspension
  - Maintain separation distances
Design Considerations

• Guidance from HI-9.8:
  – Channel approach velocity – 1.25 FPS max
  – Wing walls to allow parallel uniform inlet flow
  – Pump suction intake velocity 1 FPS max
  – Vented separation walls to prevent eddys and vortexing
  – Submergence exceed NPSHR
  – Usable sump volume exceeds 3X max of all running pumps
Design Considerations

• Coatings
  – Chemical Resistance
  – “Bridgability”
  – Maintenance

• Acoustics

• Maintenance
  – Basins = Dirt
  – Partitioned basins
  – Basin flow velocity
  – Debris screens
  – Filters or separators
Design Considerations

- Maintenance
  - Basins = Dirt
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Design Example – UNC Chapel Hill

- UNC Chapel Hill – Cogen Plant Replacement
- 13,250 GPM, 3-cell tower
- Future expansion
- Continuous operation
- Constrained site
- Acoustic design
Design Example – UNC Chapel Hill

- HVE Overhead
- Noise @ Property Line
- 6’ Grade Change
- Continuous Operation
Design Example – UNC Chapel Hill
Design Example – UNC Chapel Hill

No Water Storage

Basin Channel

Pump Bay
Design Example – UNC Chapel Hill

- Cell Basin Discharge – 1.75 FPS
- Sump Channel Velocity – 0.8 FPX
- Pump Bay Velocity – 0.3 FPS
Design Example – UNC Chapel Hill
Design Example – UNC Chapel Hill
Design Example – U of Missouri

- University of Missouri – Cooling Tower Replacement
- 50,000 GPM, 5-cell tower
- 4 steam turbine generators
- Selective shutdowns
- Constrained site
Design Example – U of Missouri

Gas Turbine Plant

Retaining Wall

Fire Lane
Design Example – U of Missouri
Design Example – U of Missouri
Design Example – U of Missouri
Design Example – U of Missouri