CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Second Stakeholder Meeting for Nonresidential HVAC

Prescriptive Efficiency Requirements for Cooling Towers

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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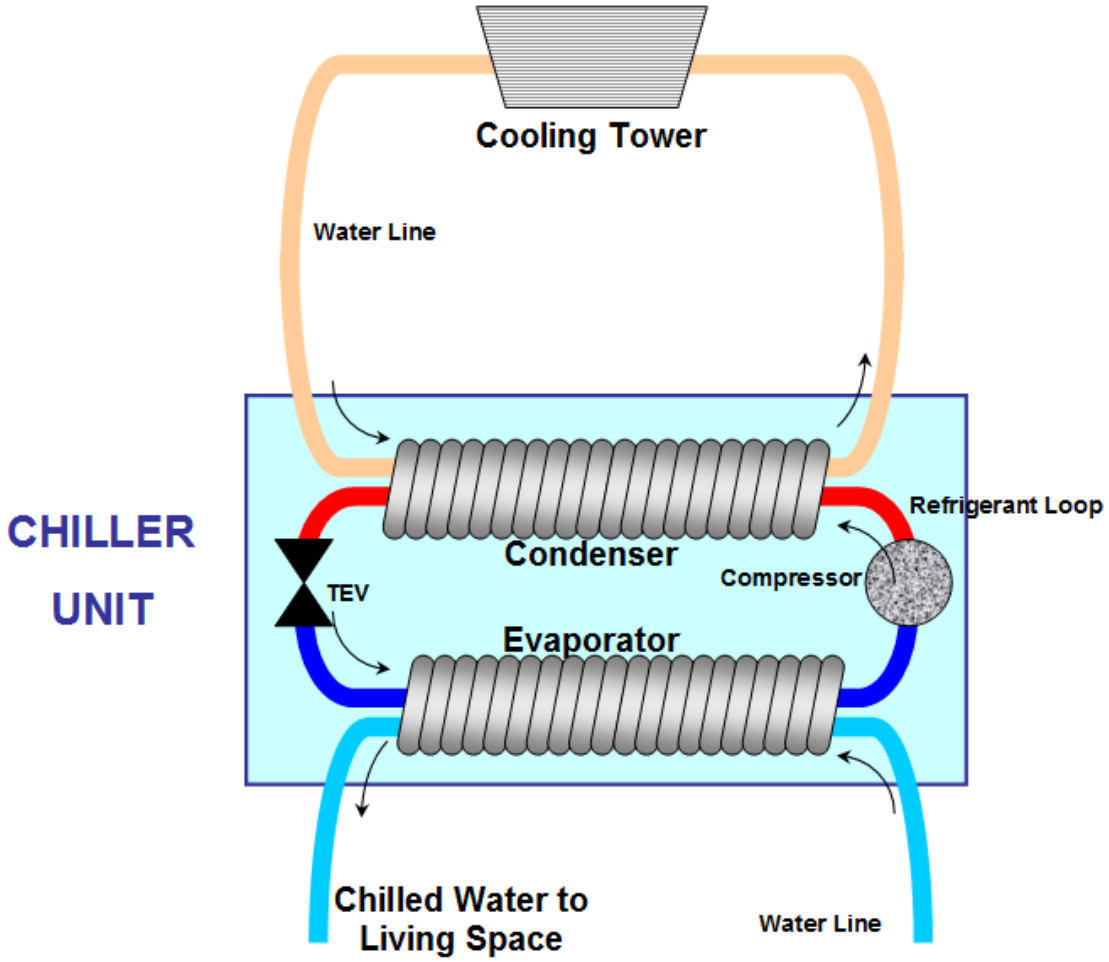
Agenda

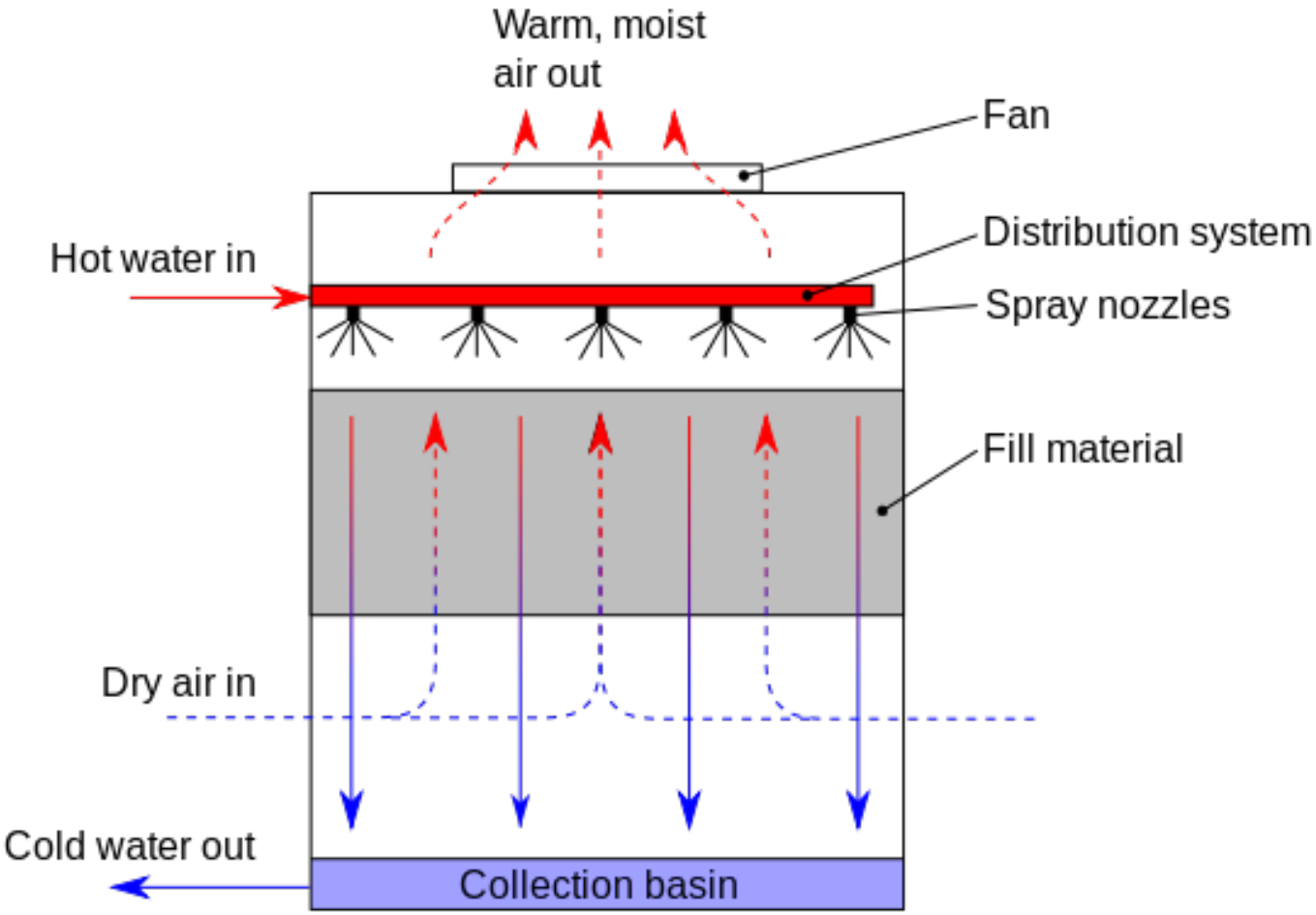
1. Background
2. Proposed Code Changes
3. Technical and Market Barriers
4. Compliance and Enforcement
5. Cost-Effectiveness and Energy Impacts
6. Next Steps

1. Background

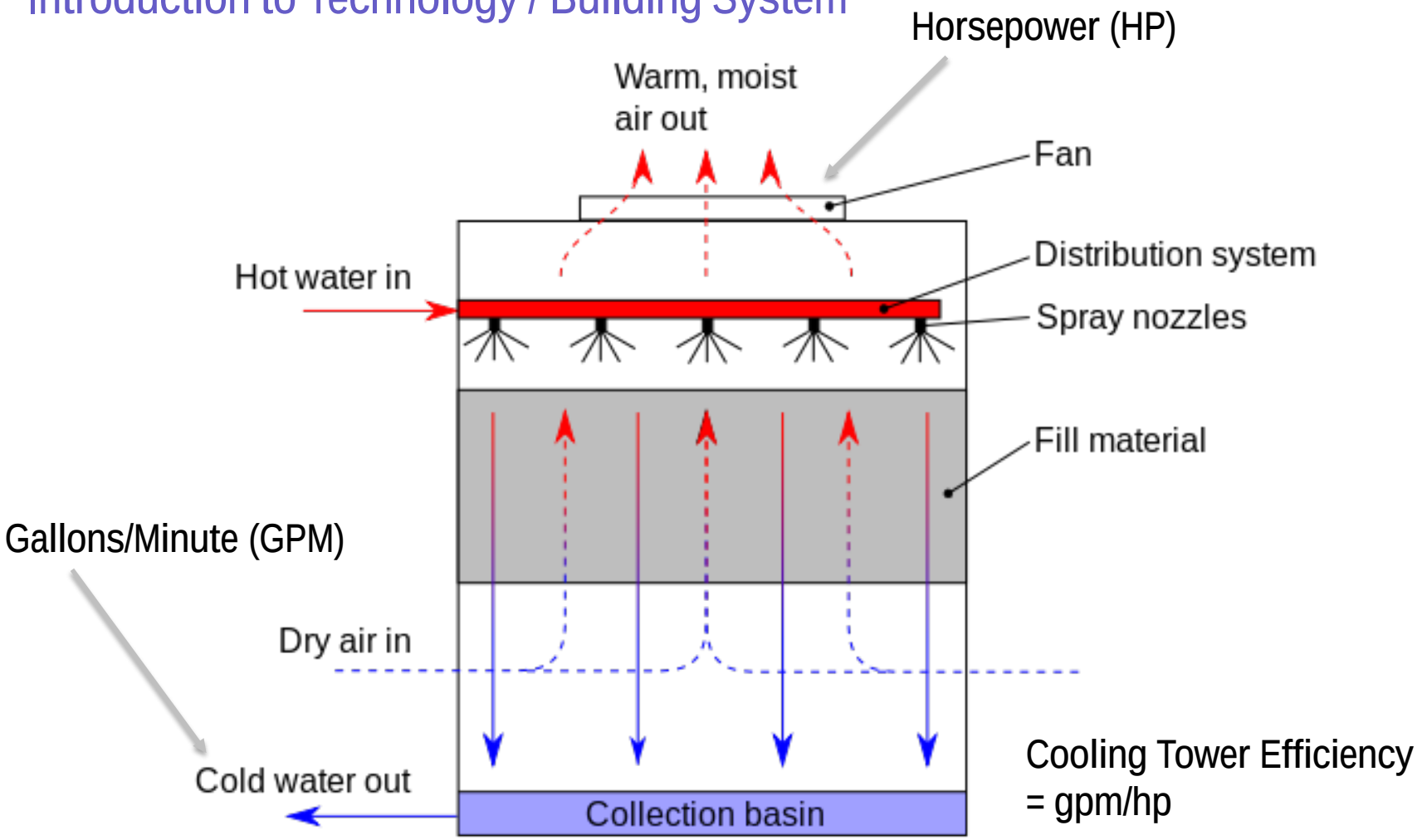
Introduction to Technology / Building System



Introduction to Technology / Building System



Introduction to Technology / Building System



Relevant Code History

- **Title 24, Part 6 Mandatory Requirement for efficiency:**
  - Minimum 38.2 gpm/hp (added 1999 cycle)
  - Increased 10% to 42.1 gpm/hp (2013 code cycle)
- **Other Relevant Code Requirements**
  - ASHRAE Mandatory Requirement – 40.2 gpm/hp
    - 52 gpm/hp for waterside economizers
  - Title 24 Limitation on Air-cooled chillers above 300 tons
  - Title 24 Limitation on Centrifugal Cooling Towers above 900 gpm
  - Title 24 Alternative Calculation Method (for performance compliance) lists Standard Design as 60 gpm/hp

Relevant Code History

- **2013 Title 24, Part 6 Code Cycle had similar CASE Measure**
  - Proposed 100 gpm/hp prescriptive requirement
    - Showed cost-effectiveness in all climate zones studied
  - Reduced proposal to 80 gpm/hp due to feedback from Cooling Tower Industry
    - Not enough products on market could meet the proposed requirements
  - Measure eventually dropped to give the cooling tower industry more time to increase efficiency of product lines
    - ASHRAE TC 8.6 (heat rejection) recommended increase in mandatory requirement from 38.2 gpm/hp to 42.1 gpm/hp
    - 2013 Title 24 ACM (for performance compliance) modified Standard Design to use 60 gpm/hp

What do you think?

- Do you understand the technology / system and how it impacts energy savings?
- Do you recognize the relevant existing code?

2. Proposed Code Changes

Proposed Code Change

- Prescriptive requirement of 80 gpm/hp for open-circuit cooling towers on condenser water plants >900 gpm
- Existing mandatory requirement remains unchanged (42.1 gpm/hp)
- ACM standard design increases from 60 gpm/hp to 80 gpm/hp
- Impacts all buildings using open-circuit cooling towers on condenser water loops > 900 gpm (mostly large office, large schools, high-rise residential)
- Applies to alterations for non-building mounted cooling towers

Why Are We Proposing This Code Change

- Support ZNE goals
- Achieve significant energy savings
- Align Prescriptive Requirements with ACM
- Follow market trends
  - Cost effective measure usually has very quick payback
  - Designers specifying higher efficiency towers
  - Cooling tower product line has improved

What do you think?

- Do you understand the proposed code change?
- Does it seem reasonable to you?

3. Technical and Market Barriers

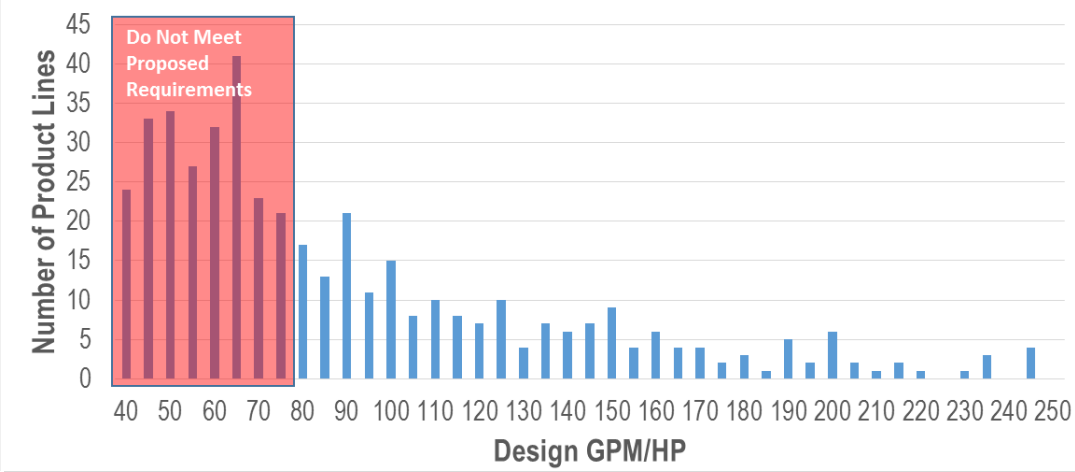
Technical and Market Barriers

- Increased Cooling Tower Space/Weight Requirements
  - More efficient cooling towers are larger
  - Projects with space constraints can use performance compliance and use a smaller/less efficient tower
    - Most large buildings use performance compliance
  - Building mounted towers in alterations are exempted
    - Ground-mounted towers can increase height if footprint is limited
  - Structural engineers indicated negligible effect on design for new construction
    - Comments?

Technical and Market Barriers

Cooling Tower Product Availability

- Reduces the number of available cooling tower products
- Only restricts the products available for **prescriptive** compliance
  - Most buildings of this size use performance compliance
- Building mounted alterations can still purchase less-efficient towers
- Cooling tower product line has improved in efficiency
- Only affects towers above **900 gpm** (approximately 300 tons)



- Survey of 900 gpm towers from SPX, BAC, Evapco
  - 46% meet prescriptive requirement
  - Comments?

What's your thinking on the barriers?

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase?
  - Coordination of equipment selection and placement
  - More efficient towers are larger and heavier, important for the design team to know and coordinate early in design process to ensure sufficient space exists

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - Equipment efficiency is certified by manufacturer
    - Product Lines are pre-certified typically, so the product selected must be pre-certified to meet 80 gpm/hp at test conditions if using prescriptive compliance
  - Some projects will be checked against mandatory minimum and some prescriptive
    - Currently only mandatory requirement checked

Compliance Process

Construction Phase

- What happens in construction phase?
  - Equipment is shipped to site and installed
    - Process is unchanged by proposal
  - Equipment undergoes acceptance test by Mechanical Acceptance Test Technician to ensure rated efficiency
    - Acceptance test must now show 80 gpm/hp if prescriptive compliance

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - Acceptance test documentation checked against prescriptive requirement and/or specified design
    - Acceptance test must show 80 gpm/hp if prescriptive compliance

Compliance and Enforcement Barriers

- Cooling tower efficiency is currently regulated
- No compliance or enforcement barriers expected

What do you think?

- Do you foresee any compliance or enforcement issues?
- If so, let's talk…

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

- **Baseline Conditions**
  - 2016 Prototype building, modified so cooling towers are minimally compliant with 2016 code
  - **Key assumptions**
    - 500,000 square foot large office
    - 42.1 gpm/hp cooling tower

- **Proposed Conditions**
  - 2016 Prototype building, modified to meet proposed minimally compliant 2019 code
  - **Key assumptions**
    - 500,000 square foot large office
    - 80 gpm/hp cooling tower

*Exploring large schools and high-rise residential prototypes

Cost Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - Cost of larger tower ($18/ton – 15% increase at $120/ton)
  - Structural impacts of heavier tower (negligible)
  - **Total Incremental First Cost ($18/ton)**
- Incremental Maintenance Costs over 15-year period of analysis
  - Maintenance Cost ($0, negligible increase)
  - **Total Incremental Maintenance Cost ($0)**
- **Total Incremental Cost over 15-year period of analysis = $18/ton**

Cost Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15-year period of analysis
  - **Total Energy Cost Savings = range of $0.04 to $0.4/sf depending on climate zone**
  - *Energy cost savings explained in more detail in following slides.*

Benefit-to-Cost Ratio

Climate Zone	Benefit to Cost
1	0.10
2	4.02
3	1.59
4	4.11
5	1.35
6	4.78
7	4.11
8	5.38
9	6.08
10	5.16
11	5.86
12	5.26
13	6.14
14	5.27
15	7.94
16	0.81

Cost Effective in These Climate Zones

If Benefit-to-Cost Ration is >1, measure is cost effective.

Annual Energy Savings per Square Foot

Climate Zone	TDV Energy Savings (TDV kBtu/yr)	15-Year TDV Energy Cost Savings ($2020)
1	0.03	$ 0.00
2	1.63	$ 0.15
3	0.59	$ 0.05
4	1.78	$ 0.16
5	0.45	$ 0.04
6	2.10	$ 0.19
7	1.80	$ 0.16
8	2.29	$ 0.20
9	2.78	$ 0.25
10	2.78	$ 0.25
11	2.55	$ 0.23
12	2.24	$ 0.20
13	2.63	$ 0.23
14	2.08	$ 0.19
15	4.53	$ 0.40
16	0.33	$ 0.03

Annual Energy Savings per Square Foot

Climate Zone	Annual Electricity Savings (kWh/yr)	Peak Electric Demand Reduction (kW)	Annual Natural Gas Savings (therms/yr)
1	0.001	3.03E-05	-
2	0.032	4.06E-05	-
3	0.012	3.69E-05	-
4	0.036	4.35E-05	-
5	0.012	3.32E-05	-
6	0.053	4.40E-05	-
7	0.041	4.37E-05	-
8	0.054	4.26E-05	-
9	0.063	4.58E-05	-
10	0.061	5.40E-05	-
11	0.058	4.36E-05	-
12	0.048	4.27E-05	-
13	0.062	4.28E-05	-
14	0.046	3.95E-05	-
15	0.120	5.71E-05	-
16	0.010	3.00E-05	-

Performance Tradeoffs – Chiller Efficiency Increase

Chiller efficiency increase for 42.1 gpm/hp tower in large office prototype

Climate Zone	Chiller Efficiency (COP)	Chiller Efficiency Increase from Minimum (6.01 COP)
1	6.3	5%
2	6.6	10%
3	6.46	7.5%
4	6.6	10%
5	6.46	7.5%
6	6.76	12.5%
7	6.6	10%
8	6.6	10%
9	6.6	10%
10	6.6	10%
11	6.6	10%
12	6.6	10%
13	6.6	10%
14	6.46	7.5%
15	6.76	12.5%
16	6.3	5%

What about the incremental costs & savings?

6. Next Steps

Next Steps

- Please send any additional feedback within 2 weeks to:
  - CASE Author (see contact info at end of this presentation)
  - Info@title24stakeholders.com
- Keep an eye on Title24Stakeholders.com for:
  - Presentations from today's meeting
  - Draft Code Change Language
  - Notes from today's meeting
  - Draft CASE Report (will be posted in April)
- CEC pre-rulemaking workshop

Let's move on to…

Economizer Fault Detection & Diagnostics (FDD) for Built-Up Air Handlers

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