CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Cooling Tower Minimum Efficiency

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Proposed Code Change Overview

- Impacts all new construction projects with cooling towers
  - All chillers >300 tons are required to have water-cooling
    - Directly impacts projects these projects if undergoing prescriptive compliance
    - Indirectly impacts projects undergoing performance compliance
- Description of proposed changes:
  - Proposed Revisions to Prescriptive Requirements :
    - Increase ALL cooling tower efficiencies (42.1 GPM/HP to 80 GPM/HP) (beyond 90.1)
  - Proposed Revisions to ACM:
    - Increase baseline cooling tower efficiency from 42.1 GPM/HP to 80 GPM/HP

Proposed Code Change History

- Why are we proposing this measure?
  - Significant energy savings opportunity for buildings with cooling towers
    - Large office buildings will see large energy savings – effectively cuts cooling tower energy use in half
    - Cost competitive, many designs incorporating more efficient towers without code mandate

Current Code Requirements

- Existing Title 24 Requirements
  - Cooling Tower Mandatory Efficiency: 42.1 HP/GPM
- Existing Model Code Requirements
  - ASHRAE 90.1 2013 Addenda cx [which did not pass] – the basis for this code change measure proposes 80 GPM/HP for cooling towers connected to waterside economizers
- Other regulatory considerations
  - Addenda cx undergoing resubmission, due to concerns regarding increased cooling tower cost and potentially pushing designers to pursue air-based systems. California requires cooling towers for all cooling plants >300 tons so it is less of an issue
    - Due to cooling tower requirements in California, this measure recommends expanding the prescriptive requirement to all cooling towers regardless of economizing strategy for additional energy savings
    - Any other issues expected due to larger cooling towers?

Typical Practices

- Current practices
  - 42.1 GPM/HP is based on current ASHRAE requirements
    - ASHRAE requires 40.2 GPM/HP – Title 24 slightly more stringent
  - More efficient cooling towers being bought for many projects without code mandate

- Do you agree with this description?

Market Overview and Analysis

- Current Market
  - ~1000 cooling tower products are sold per year statewide
  - Well established market
  - No current incentives beyond Savings By Design
- Market impacts
  - Energy consumption by this product in new construction is estimated to be 2GWH/yr
    - Based on large office prototype building energy use and large office construction statistics
- Market barriers
  - Cooling tower systems will become more costly and take more space
    - Cooling towers required by code for >300 tons cooling plants so negligible affect on sales expected
    - My complicate compliance process by forcing performance method for a large number of tower selections

- Other market information sources we should know about?
- How can we quantify the value of roof space/real estate?

Incremental Cost Estimation

- How we collected costs of base case technology and proposed technology
  - Interviews with equipment manufacturer representatives to find costs for higher efficiency tower
- What components of costs did we leave out?
  - Assumed structural penalties negligible for larger tower
  - Did not consider system redundancies
  - Did not quantify the value of additional space (rooftop or parking lot) used for larger heat rejection equipment
- We found the costs difference to be relatively low, on the order of 10-15 percent increase in cooling tower first costs for more efficient unit

- Do you find these costs to be reasonable?

Methodology for Savings Analysis

- Methodology for energy and demand Impacts
  - Energy impacts calculated through CBECC-Com, and the underlying software engines OpenStudio and EnergyPlus
  - Prototype Buildings
    - Large Office Prototype - 500,000 sf
    - Baseline System
      - 42.1 GPM/HP Cooling Tower
    - Proposed System
      - 80 GPM/HP Cooling Tower

Assumptions for Energy Impacts Analysis

- Key assumptions
  - Operating hours: ACM Standard Office – From CBECC
  - Fraction of buildings or building types containing targeted technology: All >300 tons cooling plants, assumption is new large office construction
  - All modeling assumptions based on Large Office Prototype building
- Data sources
  - Existing buildings, buildings in design, construction, and testimony from designers and product representatives all inform the modeling inputs used

Incremental Cost Savings

- Approach
  - Incremental cost savings are calculated based on TDV cost savings associated with energy savings over the entire period of analysis

Baseline Cost	Proposed Cost	Savings	% Savings
$602,520 ($1.21/sf)	$598,655 ($1.20/sf)	$3,865 ($0.01/sf)	0.6%
Baseline TDV/sf	**Proposed TDV/sf**	**Savings**	**% Savings**
101.7	99.62	2.08	2.0%

* Results calculated for Climate Zone 12, additional climate zones being considered for stakeholder meeting
** TDV Cost Multiplier: $0.029/TDV kBtu

Initial Data and Findings

- Preliminary results from savings analysis
  - 50% Heat rejection savings, as expected due to double efficiency
- Preliminary results from cost-effectiveness analysis (Benefit-Cost Ratio)
  - Modest cost impacts, $30,000 increase for larger cooling tower
    - How to account for loss of roof area?

Preliminary Energy Impacts

Preliminary Energy Savings Estimate				
Annual per Prototype Bldg Electricity Savings* (kWh/-yr)	Annual per per Prototype Bldg Natural Gas Savings* (Therms/___-yr)	First Year Statewide Electricity Savings (GWh/yr)	First Year Statewide Natural Gas Savings (Million Therms/yr)	Confidence Level (high, medium, low)
24,000	N/A	1	N/A	High

*Results calculated for Climate Zone 12, additional climate zones being considered

Preliminary Cost Effectiveness Estimates

	Benefit (2020$)	Cost (2020$)
Total Per Unit Incremental Cost over Period of Analysis		$30,000
• *Incremental first cost (supplies, equipment, installation)*		• *$0*
• *Incremental maintenance cost (replacement equipment, regular maintenance) over period of analysis*		• *$0*
Per Unit TDV Cost Savings over Period of Analysis	$58,000	
TOTAL	$58,000 ($0.12/sf)	$30,000 ($0.06/sf)
Benefit/Cost Ratio	1.93	

Compliance and Enforcement- Market Actors

- Who would be involved in implementing this measure?
  - Building Owner
  - Architect
  - Energy Consultant
  - Mechanical Designer
  - HVAC Subcontractor / Installer
  - Plans Examiner
  - Building Enforcement Agency / Inspector
  - Manufacturer

- Others?

Market Actor	Task(s)	Success Criteria
Building Owner	- Provide funding for building - Provide Owner Project Requirements (OPR)	- Building completed according to OPR - Building passes inspection
Architects	- Develop building details and sections - Coordinate equipment sizes with mechanical designer	- Satisfy owner desires - Minimal clarifications - Meet project budget
Energy Consultant	- Determine necessary compliance forms - Complete compliance documents	- Project energy goals and code requirements are met - Compliance document passes plan examination
Mechanical Designer	- Design mechanical system and details - Select equipment	- Design to meet Title 24 code - Do this cost-effectively

- What are we not capturing?

Market Actor	Task(s)	Success Criteria
HVAC Subcontractor / Installer	- Install HVAC system - Select correct equipment	- Meet schedule - Complete within budget - Passes inspection
Plans Examiner	- Ensures building is designed to code	- Forms are completed correctly - Do this with minimal training
Building Inspector	- Verify equipment is registered with Title 24 - Ensures building is designed to code - Issue Certificate of Occupancy	- Do this quickly - Get things right the first time - Do this with minimal training
Manufacturer	- Sell products to engineers which meet code	

- What are we not capturing?

Market Actor	Resource(s)
Building Owner	- EnergyCodeAce
Architects	- EnergyCodeAce - Building Owner - Energy Consultant
Energy Consultant	- CBECC-com compliance software - Title 24 Standard and supporting documents - EnergyCodeAce - CEC hotline
Mechanical Designer	- Energy Consultant - Title 24 Standard and supporting documents - EnergyCodeAce

- What resources or tools are typically used for compliance?

Market Actor	Resource(s)
HVAC Subcontractor / Installer	- Mechanical Designers - EnergyCodeAce
Plans Examiner	- Title 24 Standard and supporting documents - EnergyCodeAce
Building Inspector	- Title 24 Standard and supporting documents - EnergyCodeAce - Training
Manufacturer	- EnergyCodeAce

- What resources or tools are typically used for compliance?

Strawman Code Change Language

- Title 24 Part 6
- 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

Cooling towers connected to chiller condenser water loops must meet the requirements specified in Table 140.4-E

TABLE 140.4-E PRESCRIPTIVE PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required , a ,b, c, d	Test Procedure
Propeller or axial fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥80 gpm/hp	CTI ATC-105 and CTI STD-201

Feedback Request from Stakeholders

- *We would like your input…*
  - Ideas on Cooling Tower Efficiency Requirements
  - Thoughts on pushing beyond ASHRAE 90.1
- Please provide input by:
  - Calling or emailing CASE Author
  - Emailing info@title24stakeholders.com

Thank you.

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