



**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
<ul style="list-style-type: none"> • <i>Incremental first cost (supplies, equipment, installation)</i> • <i>Incremental maintenance cost (replacement equipment, regular maintenance) over period of analysis</i> 		<ul style="list-style-type: none"> • \$0 • \$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	<ul style="list-style-type: none"> - Provide funding for building - Provide Owner Project Requirements (OPR) 	<ul style="list-style-type: none"> - Building completed according to OPR - Building passes inspection
Architects	<ul style="list-style-type: none"> - Develop building details and sections - Coordinate equipment sizes with mechanical designer 	<ul style="list-style-type: none"> - Satisfy owner desires - Minimal clarifications - Meet project budget
Energy Consultant	<ul style="list-style-type: none"> - Determine necessary compliance forms - Complete compliance documents 	<ul style="list-style-type: none"> - Project energy goals and code requirements are met - Compliance document passes plan examination
Mechanical Designer	<ul style="list-style-type: none"> - Design mechanical system and details - Select equipment 	<ul style="list-style-type: none"> - Design to meet Title 24 code - Do this cost-effectively

- What are we not capturing?

Market Actor	Task(s)	Success Criteria
HVAC Subcontractor / Installer	<ul style="list-style-type: none"> - Install HVAC system - Select correct equipment 	<ul style="list-style-type: none"> - Meet schedule - Complete within budget - Passes inspection
Plans Examiner	<ul style="list-style-type: none"> - Ensures building is designed to code 	<ul style="list-style-type: none"> - Forms are completed correctly - Do this with minimal training
Building Inspector	<ul style="list-style-type: none"> - Verify equipment is registered with Title 24 - Ensures building is designed to code - Issue Certificate of Occupancy 	<ul style="list-style-type: none"> - Do this quickly - Get things right the first time - Do this with minimal training
Manufacturer	<ul style="list-style-type: none"> - Sell products to engineers which meet code 	

- What are we not capturing?

Market Actor	Resource(s)
Building Owner	<ul style="list-style-type: none"> - EnergyCodeAce
Architects	<ul style="list-style-type: none"> - EnergyCodeAce - Building Owner - Energy Consultant
Energy Consultant	<ul style="list-style-type: none"> - CBECC-com compliance software - Title 24 Standard and supporting documents - EnergyCodeAce - CEC hotline
Mechanical Designer	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Mechanical Designers - EnergyCodeAce
Plans Examiner	<ul style="list-style-type: none"> - Title 24 Standard and supporting documents - EnergyCodeAce
Building Inspector	<ul style="list-style-type: none"> - Title 24 Standard and supporting documents - EnergyCodeAce - Training
Manufacturer	<ul style="list-style-type: none"> - 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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