DOCKETED

Docket Number:	17-BSTD-01
Project Title:	2019 Building Energy Efficiency Standards PreRulemaking
TN #:	219864
Document Title:	Presentation - Cooling Tower Efficiency
Description:	By: Mark Alatorre
Filer:	Hilary Fiese
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	6/23/2017 10:30:12 AM
Docketed Date:	6/23/2017

Cooling Tower Efficiency

Mark Alatorre
Building Standards Office
Efficiency Division

Pre-Rulemaking Workshop
Imbrecht Hearing Room
June 20, 2017

Acknowledgements

California Statewide Codes and Standards Team

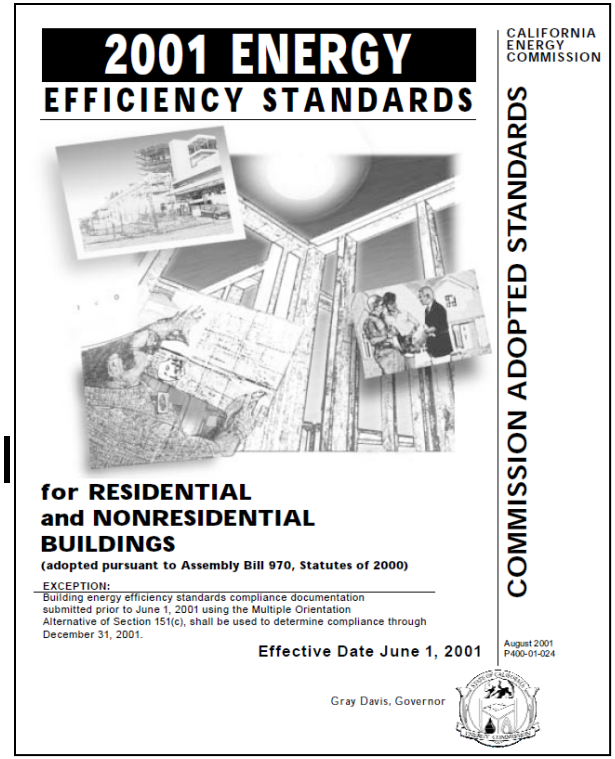
CASE Authors:

- Stefan Gracik (Integral Group)
- Matthew Dehghani (Integral Group)
- Anna Brannon (Integral Group)

Background

Cooling Tower Efficiency was first regulated under the 2001 Building Energy Efficiency Standards

- 38.2 gpm/hp propeller or axial fan cooling tower
- 5% of towers could not meet



Background

Attempts to increase cooling tower efficiency

2013 Rulemaking

- CASE Team found that 100 gpm/hp was cost effective

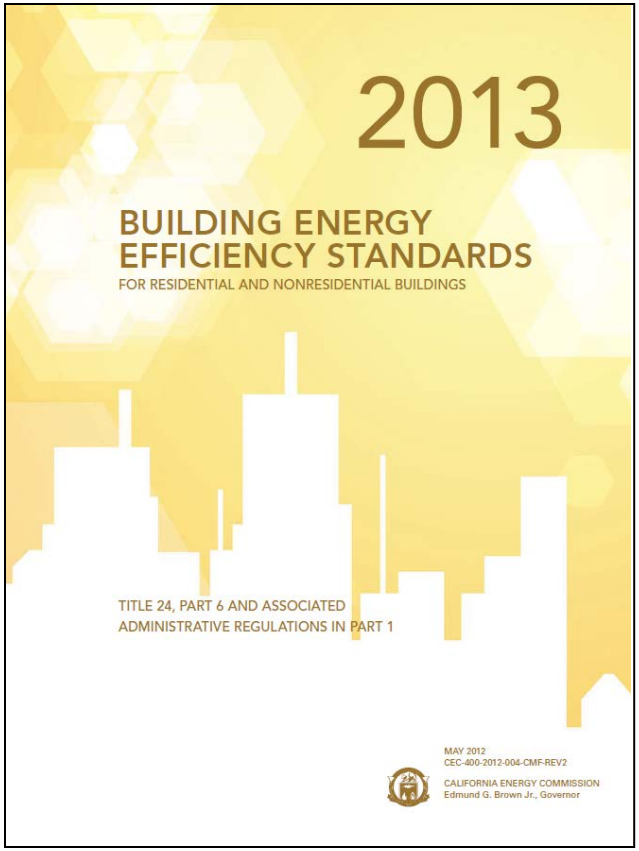
Industry Reaction

- Nearly 90% of the cooling towers available could not meet the efficiency
- Push industry to air cooled chiller plants

Background

Cooling Tower Efficiency updated under the 2013 Building Energy Efficiency Standards

- From 38.2 gpm/hp to 42.1 gpm/hp
- More efficient than 90.1
  - 40.1 gpm/hp



Proposed Code Change

CASE Team is proposing an increase to open circuit cooling tower efficiency

- 42.1 gpm/hp to 80 gpm/hp
- Prescriptive
- Applicable to new or replacement
- For systems 900 gpm and larger

Potential Issues

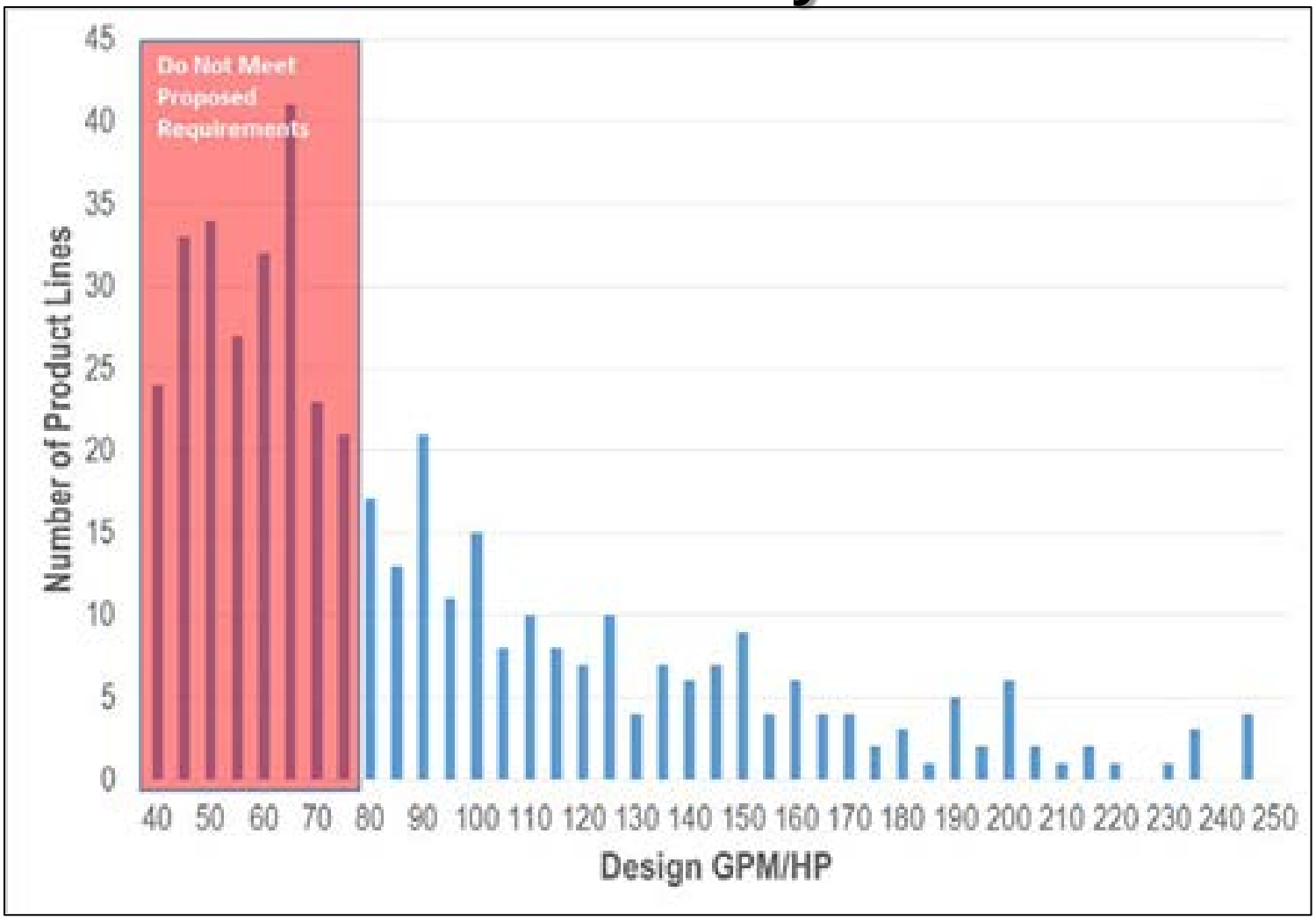
Previous attempts to increase efficiency resulted in concern about pushing the industry to air cooled systems

- Unlike 90.1, the Energy Efficiency Standards require chiller plants over 300 tons to be water cooled

From previous Stakeholder Meetings

- Product availability
- Structural design
- Available space

Product Availability



Potential Issues

Concern about added structural costs for building mounted towers

- CASE Team found that an 80 gpm/hp tower results in 30% – 40% more weight
- Interview with structural engineering firm
- Conclusion that the added weight will not result in a significant impact
- Double the weight could increase cost ~$2,000 (cost of steel)

Potential Issues

Concern about roof/space to accommodate a larger tower

- Proposed code change is prescriptive
- Towers can be taller
- Not all towers are roof mounted
- Exception for tower replacements for building mounted cooling towers

Energy Analysis

- Two Prototype Buildings were used
- CBECC-Com with 2019 TDV

Prototype ID	Occupancy Type (Residential, Retail, Office, etc.)	Area (Square Feet)	Number of Stories	Statewide Area (Million Square Feet)
Prototype 1	Office	500,000	13	**20.52**
Prototype 2	School	210,885	2	**6.35**

Energy Analysis – First Year Energy Savings per ft^2

Large Office			
Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	**TDV Energy Savings (TDV kBtu/yr)**
1	0.001	3.03E-05	**0.03**
2	0.032	4.06E-05	**1.63**
3	0.012	3.69E-05	**0.59**
4	0.036	4.35E-05	**1.78**
5	0.012	3.32E-05	**0.45**
6	0.053	4.40E-05	**2.10**
7	0.041	4.37E-05	**1.80**
8	0.054	4.26E-05	**2.29**
9	0.063	4.58E-05	**2.78**
10	0.061	5.40E-05	**2.78**
11	0.058	4.36E-05	**2.55**
12	0.048	4.27E-05	**2.24**
13	0.062	4.28E-05	**2.63**
14	0.046	3.95E-05	**2.08**
15	0.120	5.71E-05	**4.53**
16	0.010	3.00E-05	**0.33**

Energy Analysis – First Year Energy Savings per ft^2

Large School			
Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	**TDV Energy Savings (TDV kBtu/yr)**
1	0.000	1.33E-05	**0.01**
2	0.014	2.55E-05	**0.79**
3	0.004	2.00E-05	**0.24**
4	0.016	2.70E-05	**0.81**
5	0.004	2.01E-05	**0.16**
6	0.023	2.43E-05	**0.96**
7	0.017	2.33E-05	**0.79**
8	0.024	2.45E-05	**1.11**
9	0.031	2.85E-05	**1.52**
10	0.028	2.90E-05	**1.37**
11	0.029	2.76E-05	**1.30**
12	0.023	2.60E-05	**1.14**
13	0.031	2.66E-05	**1.34**
14	0.023	2.49E-05	**1.08**
15	0.068	3.94E-05	**2.70**
16	0.004	1.94E-05	**0.13**

Energy Analysis – 15 Year Energy Cost Savings per ft^2

Large Office			
Climate Zone	15-Year TDV Electricity Cost Savings (2020 PV $)	15-Year TDV Natural Gas Cost Savings (2020PV $)	Total 15-Year TDV Energy Cost Savings (2020PV $)
1	$0.00	-	$0.00
2	$0.15	-	$0.15
3	$0.05	-	$0.05
4	$0.16	-	$0.16
5	$0.04	-	$0.04
6	$0.19	-	$0.19
7	$0.16	-	$0.16
8	$0.20	-	$0.20
9	$0.25	-	$0.25
10	$0.25	-	$0.25
11	$0.23	-	$0.23
12	$0.20	-	$0.20
13	$0.23	-	$0.23
14	$0.19	-	$0.19
15	$0.40	-	$0.40
16	$0.03	-	$0.03

Energy Analysis – 15 Year Energy Cost Savings per ft^2

Large School			
Climate Zone	15-Year TDV Electricity Cost Savings (2020 PV $)	15-Year TDV Natural Gas Cost Savings (2020PV $)	Total 15-Year TDV Energy Cost Savings (2020PV $)
1	$0.00	-	$0.00
2	$0.07	-	$0.07
3	$0.02	-	$0.02
4	$0.07	-	$0.07
5	$0.01	-	$0.01
6	$0.09	-	$0.09
7	$0.07	-	$0.07
8	$0.10	-	$0.10
9	$0.14	-	$0.14
10	$0.12	-	$0.12
11	$0.12	-	$0.12
12	$0.10	-	$0.10
13	$0.12	-	$0.12
14	$0.10	-	$0.10
15	$0.24	-	$0.24
16	$0.01	-	$0.01

Incremental Cost

Large Office Prototype				Large Schools Prototype			
Climate Zone	Flow Rate[1] (gpm)	Percent Cost Increase of Higher-efficiency Towers[2]	Average Actual Efficiency (gpm/hp)	Climate Zone	Flow Rate[1] (gpm)	Percent Cost Increase of Higher-efficiency Towers[2]	**Average Actual Efficiency (gpm/hp)**
1	1,125	17%	83.2	1	1,076	21%	**92.6**
2	1,506	21%	88.4	2	943	21%	**107.7**
3	1,369	18%	95.0	3	740	11%	**94.6**
4	1,610	16%	81.9	4	1,002	19%	**105.7**
5	1,231	14%	86.0	5	743	11%	**94.6**
6	1,627	15%	82.4	6	900	12%	**93.4**
7	1,619	16%	81.9	7	862	14%	**90.9**
8	1,579	18%	81.9	8	907	12%	**93.4**
9	1,696	17%	86.5	9	1,057	22%	**100.2**
10	2,002	13%	89.2	10	1,075	21%	**92.6**
11	1,614	16%	81.9	11	1,023	17%	**105.7**
12	1,581	18%	81.9	12	964	20%	**113.2**
13	1,585	16%	81.9	13	984	19%	**113.2**
14	1,464	20%	99.2	14	924	11%	**93.4**
15	2,115	8%	91.7	15	1,459	20%	**99.2**
16	1,487	21%	87.4	16	718	12%	**100.0**

Lifecycle Cost Effectiveness Summary per ft^2

Large Office

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings1 (2020 PV $)	Costs Total Incremental Present Valued (PV) Costs2 (2020 PV $)	Benefit-to- Cost Ratio
1	$0.00	$0.03	0.08
2	$0.15	$0.05	2.83
3	$0.05	$0.04	1.35
4	$0.16	$0.04	3.93
5	$0.04	$0.03	1.48
6	$0.19	$0.04	4.78
7	$0.16	$0.04	3.94
8	$0.20	$0.05	4.48
9	$0.25	$0.05	5.37
10	$0.25	$0.04	6.11
11	$0.23	$0.04	5.61
12	$0.20	$0.05	4.38
13	$0.23	$0.04	5.88
14	$0.19	$0.05	3.89
15	$0.40	$0.03	14.90
16	$0.03	$0.05	0.58

Lifecycle Cost Effectiveness Summary per ft^2

Large School

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings1 (2020 PV $)	Costs Total Incremental Present Valued (PV) Costs2 (2020 PV $)	Benefit-to- Cost Ratio
1	$0.00	$0.02	0.03
2	$0.07	$0.03	2.18
3	$0.02	$0.01	1.57
4	$0.07	$0.03	2.41
5	$0.01	$0.01	1.08
6	$0.09	$0.02	4.79
7	$0.07	$0.02	3.56
8	$0.10	$0.02	5.54
9	$0.14	$0.04	3.69
10	$0.12	$0.04	3.38
11	$0.12	$0.03	4.08
12	$0.10	$0.03	3.24
13	$0.12	$0.03	4.07
14	$0.10	$0.02	5.9
15	$0.24	$0.05	5.06
16	$0.01	$0.01	0.83

Proposed Code Language

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(h) Heat Rejection Systems.

6. Cooling tower efficiency. New or replacement open-circuit cooling towers serving condenser water loops which total 900 gpm or greater, shall have a rated efficiency of no less than 80 gpm/hp when rated in accordance to the test procedures and rating conditions as listed in Table 110.2-G.

EXCEPTION 1 to Section 140.4(h)6: Replacement of existing cooling towers that are inside an existing building or on an existing roof.

EXCEPTION 2 to Section 140.4(h)6: Buildings in Climate Zone 1 and 16

Questions?

Mark Alatorre
mark.alatorre@energy.ca.gov
(916) 654-4642

Comments Due by July 7th
Docket Number 2017-BSTD-01
docket@energy.ca.gov