TITLE 24, PART 6 | 2025 CODE CYCLE

Refrigeration

Codes and Standards Enhancement (CASE) Proposal

Non-Residential | Refrigerated Warehouse Evaporator Efficiency

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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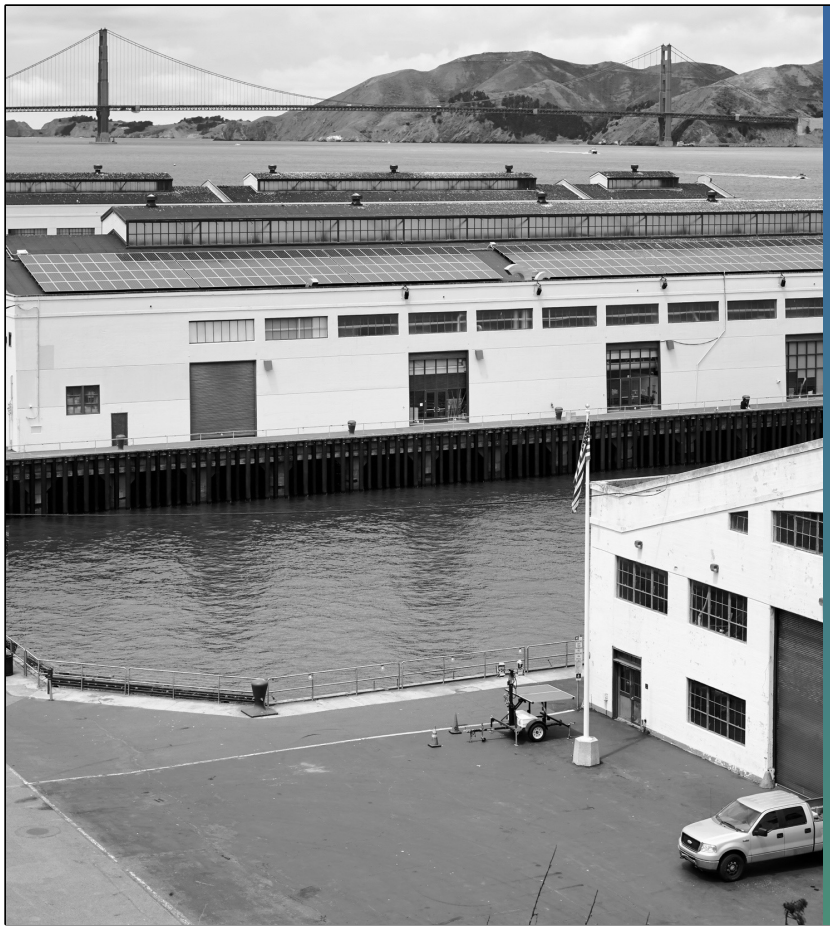

Background

- Code Change Proposal
- 2022 Code Requirements
- Context and History

Proposed Code Change

Add minimum fan-powered evaporator specific efficiency requirements for refrigeration systems in refrigerated warehouse spaces >3,000sqft using the following system designs:

- Flooded/Recirculated, or DX Ammonia
- Flooded/Recirculated or DX CO2
- DX Halocarbon

Current Code Requirements

- Existing Requirements in Title 24, Part 6(a) do not exist for evaporator efficiency
  - Current requirements are limited to evaporator fan motor control and fraction EC motors on 120V or 230V evaporators.
- Model code requirements for evaporator efficiency (ASHRAE, ICC, Other States) do not exist
- The federal walk-in cooler freezer requirements does not impact target systems

Federal DOE walk-in Requirements apply to spaces less than 3,000sqft, which is uncommon for most refrigerated warehouses.

Context and History

- Industrial fan-powered evaporators absorb heat from air inside cooler or freezer spaces of a refrigerated warehouse.
- Existing requirements for evaporators are mandated to have variable speed or use EC motors for fraction horsepower motors.
- Specific efficiency defined as capacity at selected rating conditions divided by power at full speed.
- Approach has been successfully deployed for many years for refrigeration condensers.
- Proposal will set a minimum requirement for these evaporator units so new units being installed are selected with low energy fans.
- Statewide CASE Team proposed same revision in the 2022 code cycle, but the CEC did not adopt due to resource constraints.

See the 2022 CASE Report for more details.

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

Current Market

- **Well-established market** with many evaporator manufacturers supplying new construction at varied efficiencies

Market Trends

- Trend toward higher specific efficiency evaporators as equipment designs are optimized
- More systems utilizing low charge ammonia and CO2 refrigerant designs
- Foreign companies supplying equipment to California

Market Barriers

- **No known market barriers.** Evaporators are already a well-established product with manufacturers offering a variety of models to fit a customers' requirements with multiple levels of efficiency.

More Ammonia and CO2 compared to conventional refrigerants with high GWP due to State and Federal regulatory changes.

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

Technical Considerations

- Consistent capacity and power rating basis across all manufacturing types
- Need to provide requirements for different refrigerants and uses, particularly for process loads which may or may not be exempt
- How to address floor mounted and penthouse units with additional pressure drop due to ducting

Technical Barriers and Potential Solutions

- Obtaining data for evaporators at specific conditions as manufacturer testing methods have been inconsistent, generating some uncertainty in having requirements
- Manufacturer testing has improved, with more advanced testing and focus on two main types of ratings

Floor mounted and penthouse units (which hang from ceiling) would have pressure drop due to duct work, compared to ceiling hung units that do not have duct work.

Testing methods utilized commonly are AHRI-420, AHRI-410, ASHRAE Standard 33.

Energy and Cost Impacts Per Square Foot

Methodology and Assumptions

- Energy Savings Methodology and Results
- Cost Impacts Methodology
  - Incremental costs
  - Energy cost savings

Methodology for Energy Impacts Analysis

- Methodology for per square foot energy and demand impacts:
  - Use anonymized existing equipment performance data to develop range of available evaporator efficiencies based on refrigerant type and use
  - Interview manufacturers, contractors, and end users to understand efficiency trends
  - Analyze prototypes with varying evaporator efficiency levels using DOE2.2R models from previous code cycles

Prototype Buildings	Size	System Configuration
Large Refrigerated Warehouse	92,000 sq ft	Single Stage; LT, MT Suction Groups
Small Refrigerated Warehouse	26,000 sq ft	Separate LT and MT systems

- All 16 California climate zones to be analyzed

Assumptions for Standard and Proposed Designs

Evaporator Application	Liquid Feed Type	Refrigerant Type	Standard Design Minimum Efficiency	Proposed Design Minimum Efficiency
Freezer	Direct Expansion	Halocarbon	34 Btuh/W	40 Btuh/Watt
		Ammonia	20 Btuh/W	25 Btuh/Watt
	Flooded/ Recirculated Liquid	Ammonia	34 Btuh/W	45 Btuh/Watt
Cooler	Direct Expansion	Halocarbon	34 Btuh/W	45 Btuh/Watt
		Ammonia	20 Btuh/W	35 Btuh/Watt
	Flooded/ Recirculated Liquid	Ammonia	34 Btuh/W	50 Btuh/Watt

Preliminary Energy Savings Estimates Per Square Foot

Evaporator Application	Liquid Feed Type	Refrigerant Type	Annual Electricity Savings (kWh/yr)	TDV Savings (kBtu/yr)
Freezer	Direct Expansion	Halocarbon	0.37 - 0.42	10.03 - 11.93
		Ammonia	0.76 - 0.94	20.84 - 30.23
	Flooded/ Recirculated Liquid	Ammonia	0.45 - 0.49	12.73 - 28.57
Cooler	Direct Expansion	Halocarbon	0.63 - 0.87	17.08 - 24.82
		Ammonia	1.95 - 2.83	53.20 - 80.29
	Flooded/ Recirculated Liquid	Ammonia	0.61 - 0.83	17.94 - 33.07

- No demand savings, due to common practice of demand response and load shedding during peak periods.
- No natural gas savings

2022 Title 24, Part 6 Final CASE Report – 2022-NR-COV-PROC2-F Refrigerated System Opportunities

Incremental Cost Information

We will collect costs of base case technology and proposed technology:

- Collect anonymized cost data from manufacturers
- Develop average $/Btuh/W for evaporators across different refrigerants and evaporator types to determine incremental cost associated with more efficient equipment
- Costing based on standard unit without controls, such as electronic expansion valves.

Preliminary Cost Effectiveness

Evaporator Application	Liquid Feed Type	Refrigerant Type	Benefit-to-Cost Ratio
Freezer	Direct Expansion	Halocarbon	3.02 – 3.59
		Ammonia	3.21 – 4.66
	Flooded/ Recirculated Liquid	Ammonia	3.50 – 7.85
Cooler	Direct Expansion	Halocarbon	2.21 – 3.21
		Ammonia	2.57 – 3.88
	Flooded/ Recirculated Liquid	Ammonia	3.36 – 6.18

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Statewide Energy Impacts

Methodology and Assumptions

- Statewide Energy Impacts Methodology

Statewide Energy Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x B x C**:

A. per-sqft energy impacts (discussed in previous section)
B. number of sqft of new construction/additions/alterations of each applicable building type
C. portion of affected sqft in each climate zone

Example:

Per Unit Impacts

Savings type	**Savings** per square foot
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[X] Therms
GHG emissions	[X] Tons CO_2e

Affected New Construction

Climate Zone	**Large Office** sq ft	**Assembly** sq ft
1	100	20
2	1,000	1,500
…		
16	5,000	3,000

Statewide Energy Impacts

Climate Zone	**Elec Savings** (GWh)	**…**	**GHG savings** (MT CO_2e)
1	20		1,500
2	50		3,000
…			
16	100		2,000

Assumptions for Statewide Savings Estimates

Building Types	2026 New Construction Forecast	% New Construction Impacted	Total New Construction Impacted
Refrigerated Warehouses	1.3M SF	100%	1.3M SF

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection
- Revisions to Compliance Software

Compliance and Verification Process

1. **Design Phase**
   The design team develops refrigeration design loads and select the best system type and resulting equipment to supply required cooling. Based on system type, fan-powered evaporator specific efficiency requirements will be determined, allowing for sections to be made to meet or exceed the mandatory requirements. Manufacturer selection software to include evaporator specific efficiency to aide in appropriate selections.

2. **Permit Application Phase**
   Contractor develops a set of stamped engineering plan drawings on the owner's behalf, including refrigeration system design and equipment schedules. Plan drawings incorporate Compliance Forms on selected equipment that complies with Title 24, Part 6, the AHJ provides plan check comments to correct inconstancies or approves compliant plans and provides a building permits.

3. **Construction Phase**
   Contractors install the refrigeration system as described in the approved plan drawings. The installed equipment matches what was approved and specified in the equipment schedule.

4. **Inspection Phase**
   Before issuing a certificate of occupancy, the AHJ inspects the building and its various mechanical systems. The inspection phase includes an examination of the refrigeration system to verify the compliant equipment described in the approved design matches what was installed.

Compliance and Verification

- Process will be similar to condensers and the associated condenser-specific efficiency requirements in §120.6(a)4.
- Forms documenting the design's compliance to be updated to include specific efficiency for fan-powered evaporators.
  - EnergyCodeAce.com provides a Virtual Compliance Assistant for filling out forms using a wizard.

Market Actors

Market actors involved in implementing this measure include:

- Design engineers
- Installation contractors
- Owners/end users
- Equipment manufacturers
- Equipment manufacturer representatives

Review of Code Language Markup

- Draft Code Change Language

Draft Code Change Language

- Draft code language available for review in Handouts and downloadable.
- Provide Feedback to CASE Author by February 14, 2023

D. Fan-powered evaporators shall meet the evaporator specific efficiency requirements listed in TABLE 120.6-G at the conditions listed in TABLE 120.6-F. Evaporator specific efficiency is defined as the total refrigeration capacity (Btu/h) divided by the electrical input power at 100 percent fan speed. Capacity is rated at 10°F of temperature difference between the incoming air temperature and the saturated evaporating temperature. For glide refrigerants, the saturated evaporating temperature is defined as the dewpoint temperature. Input power is rated at 100% fan speed at rated temperature conditions.

EXCEPTION to Section 120.6(a)3D: Evaporators designed solely for the purpose of quick chilling/freezing of products, including but not limited to spaces with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²).

TABLE 120.6-F FAN-POWERED EVAPORATOR SPECIFIC EFFICIENCY RATING CONDITIONS

	FREEZER APPLICATION	COOLER/DOCK APPLICATION
Saturated evaporating dewpoint Temperature	-20°F	25°F
Entering air temperature	-10°F	35°F
External static pressure	0 in.WC	0 in.WC
Rating Type	Dry Coil	Dry Coil

TABLE 120.6-G FAN-POWERED EVAPORATORS - SPECIFIC EFFICIENCY REQUIREMENTS

EVAPORATOR TYPE	REFRIGERANT TYPE	MINIMUM SPECIFIC EFFICIENCY	
		COOLER/DOCK	FREEZER
Direct Expansion	Halocarbon	45 *Btuh/Watt*	40 *Btuh/Watt*
	Ammonia	35 *Btuh/Watt*	25 *Btuh/Watt*
	CO2	XX Btuh/Watt	XX Btuh/Watt
Flooded or Recirculated Liquid	Ammonia	50 *Btuh/Watt*	45 *Btuh/Watt*
	CO2	XX Btuh/Watt	XX Btuh/Watt

E. The applied static pressure drop for evaporators installed in refrigerated warehouses shall not exceed 0.5" water column.

EXCEPTION to Section 120.6(a)3E: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling/freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²)).

Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the chat
- More information on pre-rulemaking for the 2025 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Comments on this measure are due by February 14, 2023. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

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