2013 Building Energy Efficiency Standards Staff Workshop

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California Energy Commission

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Workshop Agenda

Proposals for the 2013 Update the Nonresidential Building Energy Efficiency Standards

- Design Phase Commissioning
- Acceptance Testing
- Lunch
- Commercial Refrigeration
- Refrigerated Warehouse

2013 Title 24 (Part 6) Update:
Policy Objectives

- Achieve big step towards Zero Net Energy codes in 2020 (res) & 2030 (nonres) - 15-25% improvement in Standards
- Include CEC Approved Reach Standards - propose for Energy Chapter of Title 24, Part 11 (CA Green Building Standards)
- Align with CA Building Standards Commission's triennial code update

2013 Title 24 (Part 6) Update Schedule

Solicitation/Procurement Complete RFQ & contract procurement for 2011 Standards Technical Support; develop measure templates for 2011 Standards to document the benefits and the impacts of the proposed measures	Nov 2008 - Feb 2010
Pre-Rulemaking Activities: Phase 1 **Phase 1A -** Begin CASE Studies: Prioritize topic areas that contribute most to project goals and complete initial measure analysis **Phase 1B –** Foundational work (TDV, LCC, Weather) and initial software development **Phase 1C -** 2008 Standards Cleanup – Identify Standards and reference document sections that need clarification or revision and prepare initial mark-ups	Nov 2009 - Oct 2010
Pre-Rulemaking Activities: Phase 2 - CASE Studies Phase 2 1. First staff workshop - present info on weather data, TDV and cost effectiveness methodology 2. Stakeholder meetings – conduct as necessary to obtain comment on specific topic areas of proposed changes	Oct 2010 - Dec 2010
Pre-Rulemaking Activities: **Phase 3A - Draft Standards and Rulemaking Documents** Reconcile comments in preparation for draft regulation workshops, including analysis rework and markup Standards documents; **Phase 3B -** Conduct workshops for presentation of proposed draft revisions to Standards documents comments from the workshops into the proposed **first draft Standards** documents; **Phase 3C –** Prepare the second draft language; draft rulemaking documents; close pre-rulemaking Docket.	Feb - Apr 2011 Apr - Jul 2011 Jul - Sep 2011
Rulemaking Activities: Phase 4 – Adopt Standards and Associated Documents Open Rulemaking Docket; file Rulemaking documents with CBSC; develop **45-Day and 15-Day Language Standards documents**; develop and complete Administrative Procedures Act process requirements for rulemaking proceeding; complete and file Fiscal and Economic Impact Analysis and Environmental Analysis documents with required agencies	Sep 2011 - Mar 2012
Adoption - CEC adoption of 45-Day or 15-Day Standards and associated regulations; close Rulemaking Docket	**March 1, 2012**
Post adoption Activities Prepare and develop Final Statement of Reasons and other rulemaking documentation for CBSC approval	Feb 2012 - May 2012
Compliance Manuals and Software Development Develop and finalize the Compliance manuals review and finalize performance approach software	Mar 2012 - Dec 2012 Jun 2011 - Dec 2012
CBSC Publication Process – All T24 Parts Publication preparation 180 day statutory waiting period	Feb 2013 - **July 2013** July 2013 - Jan 2014
Effective Date	**January 2014**

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2013 Standards Update

IOUs Support, Stakeholder Meetings, Staff Workshops, Code Language Update

- The Statewide IOUs (PG&E, SCE, SDG&E, and SCG) have been holding stakeholder meetings throughout the state since Spring of 2010 in support of the 2013 Standards update.
- Staff will hold several workshops in April-June of 2011 to present the draft Standards at the conclusion of the IOUs' stakeholder meeting process.
- Staff will prepare 45-day language July-September, 2011

Design Phase Commissioning (Cx)

What is Design Review?

It is a key part of building commissioning protocol that:

- ✓ Confirms design conforms to project requirements
- ✓ Checks documents are clear and complete
- ✓ Checks documents are free from significant error
- ✓ Suggests best practice design enhancements

Design Review in the Code Compliance Context

- ✓ Confirm design conforms to codes
- ✓ Confirm performance path energy modeling inputs are reflected in design documents
- ✓ Confirm that CALGreen and Acceptance Testing
- ✓ Requirements are reflected in design documents

Design Phase Commissioning (Cx)

Benefits of Design Review

- Cost & Time
  - ✓ Reduce number of significant change orders
  - ✓ Reduce administrative time issuing RFIs and change orders
  - ✓ Reduce delays associated with resolving deficiencies
- Save Energy
  - ✓ Increase compliance with Title 24 energy requirements
  - ✓ Increase best practices that go beyond Title 24
- Quality Building
  - ✓ Operates as intended
  - ✓ Is easier to construct and maintain
  - ✓ Has lower long term operating cost

Design Phase Commissioning (Cx)

Objectives of Design Review in Title 24, Part 6

- Effective – not overly burdensome
- Practical –targets items with most impact
- Not duplicative of existing T24 compliance processes
- Effort and cost is scalable to project size
- Integrated with Acceptance Testing and CALGreen (Title 24, Part 11) Cx requirements
- Enforceable

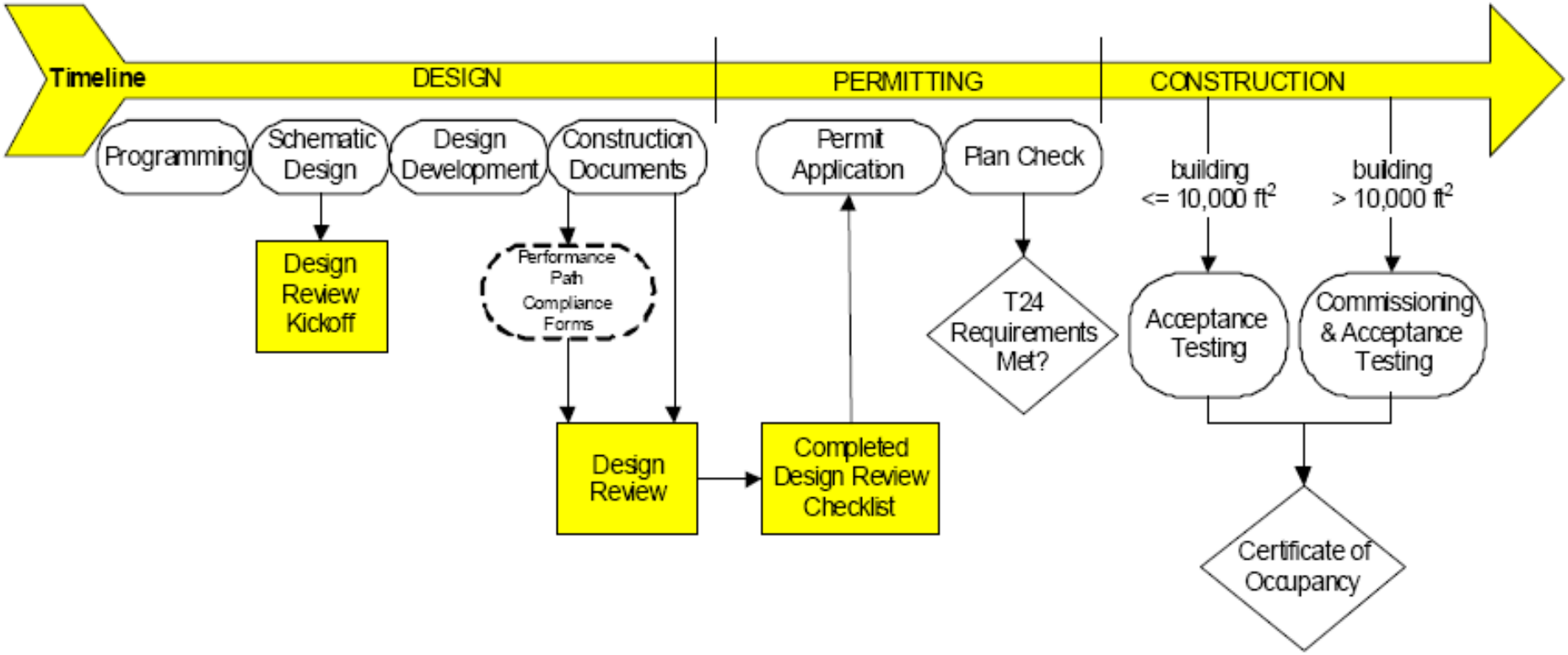
Design Phase Commissioning (Cx)

Proposed Requirements

- Design Review for all Nonresidential projects
  - ✓ Design Review varies with building size and system types (simple or complex)
  - ✓ Two Part Process: schematic design kickoff meeting and construction document design review checklists
- Design Reviewer Qualifications:
  - ✓ Self Review for simple systems and < 10K sqft
  - ✓ In-house review < 50,000 sqft by registered engineer (engineering associate with no project involvement)
  - ✓ 3rd party review > 50,000 sqft or complex HVAC systems by registered engineer

Design Phase Commissioning (Cx)

Proposed Requirements



Design Phase Commissioning (Cx)

Schematic Design Kick-Off Meeting

1. Initial coordination to define project and Design Review needs
2. Hold kick–off meeting with owner and project team
3. Discuss Design Review process and present required and best practice checklists
4. Discuss future CD Design Review approach and timing / scheduling factors

Design Phase Commissioning (Cx)

Construction Documents Design Review

1. Substantially complete design docs distributed
2. Design Reviewer performs checklist review
3. Signed Design Review form sent to owner and project team
4. Project team addresses review comments
5. Design Review forms/sign-off are printed on Bid Set and submitted with application
6. Code official confirms signed forms are included in plans as part of compliance check

Design Phase Commissioning (Cx)

Estimated Cost of Design Review Requirements

- Simple and small building (<10,000sqft)
  - self design review ~ 16 hours
- Simple and moderate building (30,000 sqft)
  - in house design review ~ 50 hours
- Larger and complex building (200,000 sqft)
  - 3rd party design review ~ 145 hours
    - Design Reviewer ~ 40% of hours
    - Designer ~ 60% of hours

Design Phase Commissioning (Cx)

Savings Methodology

- Energy simulations w/ and w/o compliance with efficiency measures most often identified and fixed as part of Design Review process
- Resulting energy savings discounted significantly based on:
  - ✓ Typical frequency of fault occurrence
  - ✓ Ability of Design Review to identify faults
  - ✓ Expected compliance with Design Review requirements
- Slight upward savings adjustment based on evidence that Design Review often results in adoption of additional efficiency measures

Design Phase Commissioning (Cx)

Cost Effectiveness

CZ	College		Office-Large		Office-Small		Retail		Restaurant		School	
	Cost ($/sf):	$ 0.24		$ 0.22		$ 0.34		$ 0.35		$ 0.46		$ 0.25
	Value (TDV $/sf)	Value /Cost Ratio	Value (TDV $/sf)	Value /Cost Ratio	Value (TDV $/sf)	Value /Cost Ratio	Value (TDV $/sf)	Value /Cost Ratio	Value (TDV $/sf)	Value /Cost Ratio	Value (TDV $/sf)	Value /Cost Ratio
1	$ 0.94	4.0	$ 1.20	5.4	$ 1.42	4.2	$ 0.81	2.3	$ 1.64	3.6	$ 0.55	2.2
2	$ 1.60	6.8	$ 1.94	8.8	$ 1.43	4.2	$ 0.87	2.5	$ 2.04	4.4	$ 0.60	2.4
3	$ 1.34	5.7	$ 1.69	7.6	$ 1.35	4.0	$ 0.79	2.2	$ 1.80	3.9	$ 0.51	2.0
4	$ 1.37	5.8	$ 1.75	7.9	$ 1.44	4.3	$ 0.83	2.4	$ 1.88	4.1	$ 0.51	2.1
5	$ 1.33	5.7	$ 1.69	7.6	$ 1.35	4.0	$ 0.79	2.2	$ 1.80	3.9	$ 0.50	2.0
6	$ 1.30	5.5	$ 1.68	7.6	$ 1.44	4.3	$ 0.83	2.4	$ 1.94	4.2	$ 0.51	2.0
7	$ 1.21	5.1	$ 1.59	7.2	$ 1.41	4.2	$ 0.81	2.3	$ 1.87	4.1	$ 0.48	1.9
8	$ 1.23	5.2	$ 1.63	7.4	$ 1.67	5.0	$ 0.96	2.7	$ 2.01	4.4	$ 0.72	2.9
9	$ 1.31	5.6	$ 1.70	7.7	$ 1.69	5.0	$ 0.98	2.8	$ 2.07	4.5	$ 0.74	3.0
10	$ 1.34	5.7	$ 1.73	7.8	$ 1.70	5.1	$ 0.98	2.8	$ 2.09	4.5	$ 0.75	3.0
11	$ 1.38	5.9	$ 1.74	7.9	$ 1.78	5.3	$ 1.03	2.9	$ 2.13	4.6	$ 0.83	3.3
12	$ 1.33	5.7	$ 1.68	7.6	$ 1.72	5.1	$ 1.00	2.9	$ 2.06	4.5	$ 0.80	3.2
13	$ 1.34	5.7	$ 1.71	7.7	$ 1.79	5.3	$ 1.03	2.9	$ 2.10	4.6	$ 0.81	3.3
14	$ 1.31	5.5	$ 1.69	7.6	$ 1.80	5.4	$ 1.03	2.9	$ 2.08	4.5	$ 0.80	3.2
15	$ 1.16	4.9	$ 1.64	7.4	$ 2.04	6.1	$ 1.08	3.1	$ 2.10	4.6	$ 0.77	3.1
16	$ 1.15	4.9	$ 1.41	6.4	$ 1.59	4.7	$ 0.96	2.7	$ 1.96	4.2	$ 0.68	2.7
Wt'd Avg		**5.6**		**7.6**		**4.8**		**2.6**		**4.3**		**2.7**

Simple average of all building types = 4.6

Design Phase Commissioning (Cx)

Next Steps

- Develop an effective package of Design Review Checklists
- Add Design Review Checklist generation to Compliance Software reporting requirements
- Develop Code Language

Acceptance Requirements based on Retro-Commissioning Failure Modes

Background

- CA Retro-Commissioning (RCx) program dataset
  - ✓ > 800 failures across 125 buildings
- Criteria for selecting efficiency measures for test review or creation:
  - ✓ Frequency
  - ✓ Energy Savings
  - ✓ Suitability for Acceptance requirements

Acceptance Requirements based on Retro-Commissioning Failure Modes

Proposed: Two New Acceptance Tests

- Supply Air Temperature Reset Controls
  - ✓ For multizone air handler units
  - ✓ Test SAT resets based on OAT and RAT
  - ✓ Test at high and low load conditions
  - ✓ Time required to test in range of ½ hour – 2 hours
- Condenser Water Supply Temperature Reset Controls
  - ✓ For water-cooled chillers w/ cooling tower
  - ✓ Test CWST resets based on OA wet bulb temp or load
  - ✓ Time required to test in range of ½ hour – 2 hours

Each test saves $0.14/sf

Acceptance Requirements to Improve Effectiveness and Compliance

Background

- California Commissioning Collaborative study funded by PIER: "Title 24 Acceptance Testing Requirements and Effectiveness"

Objectives:

- ✓ Improved Forms
- ✓ Improved Test Processes
- ✓ Outreach and education activities

Acceptance Requirements to Improve Effectiveness and Compliance

Key Findings

- Acceptance requirements and forms are confusing
- Tests are sometimes performed, but …
  - ✓ Financial disincentive to include in bid
  - ✓ Often not included in bid unless specified
  - ✓ Forms not often requested
  - ✓ Incorrect forms used, incomplete
  - ✓ Onsite verification uncommon

Acceptance Requirements to Improve Effectiveness and Compliance

Key Findings

- Unclear who is responsible to specify tests
- Unclear who is responsible to execute tests
- Tests are valuable
  - ✓ Equipment is functional
  - ✓ Equipment meets design intent and code
- Intent is right, but in practice the requirements are unclear and complex

Acceptance Requirements to Improve Effectiveness and Compliance

Recommendations

- Specific changes to compliance forms to
  - ✓ Improve clarity
  - ✓ Document additional details
  - ✓ Improve functional test procedures & documentation processes
- At-A-Glance Guides to be added to compliance manuals

Commissioning:
Design Review & Acceptance Testing

Commercial Refrigeration

Commercial Refrigeration

- New efficiency requirements for refrigeration systems used in supermarkets & big box retail stores
- Energy Commission partnership with CA Air Resources Board to reduce GHG emissions
  - ✓ Time Dependent Valuation of Energy Costs (TDV) includes carbon emission costs
  - ✓ TDV accounts for both indirect emissions (energy consumed) & direct emissions (refrigerant leakage)
  - ✓ Energy efficiency measures – Part 6 (Energy Efficiency Stds.)
  - ✓ Leak reduction measures – Part 11 (CA Green Building Stds.)

Commercial Refrigeration

2013 Code Change Scope

- Definitions
- Efficiency Requirements
  - ✓ Floating Head Pressure
  - ✓ Condenser Specific Efficiency
  - ✓ Floating Suction Pressure
  - ✓ Mechanical Subcooling
  - ✓ Display Case Lighting Control
  - ✓ Refrigeration Heat Recovery
  - ✓ Doors on Low Temp Display Cases
- Acceptance Testing
- Leak Reduction Measures (Part 11)

draft code language

Commercial Refrigeration

Definitions

BUBBLE POINT is the refrigerant liquid saturation temperature at a specified pressure.

COOLER is space greater than or equal to 28°F but less than 55°F.

DEW POINT is the refrigerant vapor saturation temperature at a specified pressure.

SATURATED CONDENSING TEMPERATURE (CONDENSING TEMPERATURE) is the saturation temperature corresponding to the refrigerant pressure at the condenser entrance for single component and azeotropic refrigerants. For zeotropic refrigerants, the arithmetic average of the Dew Point and Bubble Point temperatures corresponding to the refrigerant pressure at the condenser entrance.

CONDENSER SPECIFIC EFFICIENCY is the Total Heat of Rejection (THR) capacity divided by the fan input electric power at 100% fan speed (including spray pump electric input power for evaporative condensers).

FREEZER is space designed to maintain less than 28°F and space designed for convertible between cooler and freezer operation.

MICRO-CHANNEL CONDENSER is an air-cooled condenser for refrigeration systems which utilizes multiple small parallel gas flow passages in a flat configuration with unitized fin surface between the gas passages, rather than round tubes arranged at a right angle to separate plate fins.

TOTAL HEAT OF REJECTION (THR) is the heat absorbed at the evaporator plus the heat picked up in the suction line plus the heat added to the refrigerant in the compressor.

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Condensers

Evaporatively-cooled

Air-cooled

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Floating Head Pressure

- Variable speed condenser fan(s)
  - ✓ For air-cooled or evaporative-cooled condensers, air or water cooled fluid coolers, cooling towers
  - ✓ Multiple fans serving common condenser controlled in unison
- Variable condensing temperature setpoint control ("ambient following")
  - ✓ For air-cooled condensers, based on ambient drybulb temp
  - ✓ For evap-cooled condensers, based on ambient wetbulb temp
- Min. condensing temperature setpoint <= 70 deg. F

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Floating Head Pressure

(a) **Condensers**. Fan-powered condensers shall conform to the following requirements.

1. All condenser fans for air-cooled condensers, evaporative-cooled condensers, air- or water-cooled fluid coolers or cooling towers shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

2. The refrigeration system condenser controls for systems with air-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature.

3. The refrigeration system condenser controls for systems with evaporative-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient wetbulb temperature.

EXCEPTION to Section 127 (a) 2 and 3: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide equal energy savings

4. The minimum condensing temperature setpoint shall be less than or equal to 70°F.

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Condenser Specific Efficiency (CSE)

= Total Heat of Rejection / Fan Power

- Evaporative-cooled: CSE >= 160 Btuh/W

  Exceptions for THR < 150 MBH & existing condensers

- Air-cooled: CSE >= 65 Btuh/W

  Exceptions for THR < 150 MBH & existing condensers

- Air-cooled: Fin Density <= 10 fins/inch

  Exceptions for micro-channel condensers & existing condensers

NOTE: CSE not found to be cost effective in a few climates for condensers with non-EC motors – *working on exception*

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Condenser Specific Efficiency

5. Fan-powered condensers shall meet the specific efficiency requirements listed in Table 127-A:

TABLE 127-A - FAN-POWERED CONDENSERS –SPECIFIC EFFICIENCY REQUIREMENTS

Condenser Type	Minimum Specific Efficiency [a]	Rating Condition
Evaporative-Cooled	160 (Btu/h)/W	100°F Saturated Condensing Temperature (SCT), 70°F Entering Wetbulb Temperature
Air-Cooled	65 (Btu/h)/W	105°F Saturated Condensing Temperature (SCT), 95°F Entering Drybulb Temperature
[a] Condenser specific efficiency is the Total Heat of Rejection (THR) capacity divided by the fan input electric power at 100% fan speed (plus spray pump electric input power for evaporative condensers).		

EXCEPTION 1 to Section 127 (a) 5: Condensers with a THR capacity of less than 150 MBH at the specific efficiency rating condition.

EXCEPTION 2 to Section 127 (a) 5: Existing condensers that are reused for an expansion or remodel.

6. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION to Section 127 (a) 6: Micro-channel condensers.

EXCEPTION to Section 127 (a) 6: Existing condensers that are reused for an expansion or remodel.

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Compressor Systems

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Floating Suction Pressure

- Floating suction pressure control logic
  - ✓ For refrigeration compressor systems and condensing units
  - ✓ Reset suction temperature target based on temp. requirements of the attached display cases or walk-ins
- Exceptions:
  - ✓ Single compressor systems w/o variable capacity
  - ✓ Suction groups w/ design suction temp >= 30 deg. F
  - ✓ Suction groups on high stage of two-stage or cascade system
  - ✓ Suction groups that serve chillers for secondary cooling fluids

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Floating Suction Pressure

(b) Compressor Systems. Refrigeration compressor systems and condensing units shall conform to the following requirements.

1. Compressors and multiple-compressor suction groups shall include control systems that use floating suction pressure logic to reset the target saturated suction temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

EXCEPTION 1 to Section 127 (b) 1: Single compressor systems that do not have variable capacity capability.

EXCEPTION 2 to Section 127 (b) 1: Suction groups that have a design saturated suction temperature of 30°F or higher, or suction groups that comprise the high stage of a two-stage or cascade system or that primarily serve chillers for secondary cooling fluids.

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Mechanical Subcooling

- Liquid subcooling must be provided
  - ✓ For low temp parallel compressor systems w/ design suction temp <= 10 deg. F
  - ✓ Liquid temp must be maintained <= 50 deg. F
  - ✓ Use of compressor economizer ports, or
  - ✓ Use of separate parallel medium or high temp suction group w/ suction temp >= 18 deg. F
- Exceptions:
  - ✓ Single compressor systems
  - ✓ Low temp cascade systems
  - ✓ Existing compressors

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Mechanical Subcooling

2. Liquid subcooling shall be provided for all low temperature parallel compressor systems with a design saturated suction temperature of -10°F or lower, with the subcooled liquid temperature maintained continuously at 50°F or less, using compressor economizer port(s) or a separate parallel medium or high temperature suction group operating at a saturated suction temperature of 18°F or higher.

EXCEPTION 1 to Section 127 (b) 2: Single compressor systems.

EXCEPTION 2 to Section 127 (b) 2: Low temperature cascade systems that condense into another refrigeration system rather than condensing to ambient temperature.

EXCEPTION 3 to Section 127 (b) 2: Existing compressors that are reused for an expansion or remodel,

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Display Case Lighting Control

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Display Case Lighting Control

- For lighting in refrigeration display cases and lights on walk-in glass doors
- Either:
  - ✓ Automatic time switch controls to turn off lights during non-business hours
- Or:
  - ✓ Motion sensor controls on each display case
  - ✓ Reduce lighting power >= 50% within 30 minutes of non-occupancy
- Exception:
  - ✓ Stores with operating hours >= 140 per week

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Display Case Lighting Control

(d) Display Cases.

1. Lighting in refrigeration display cases, and lights on glass doors installed on walk-in coolers and freezers shall be controlled by either A or B:

    a. Automatic time switch controls to turn off lights during non-business hours. Use of timed overrides to turn the lights for stocking shall not exceed one hour for any case line-up or walk-in and if manually imitated shall time-out automatically.

    b. Motion sensor controls on each case that reduce display case lighting power by at least 50% within 30 minutes after the area near the case is vacated.

EXCEPTION 1 to Section 127 (d) 1: Stores which are normally open for business 140 hours or more per week.

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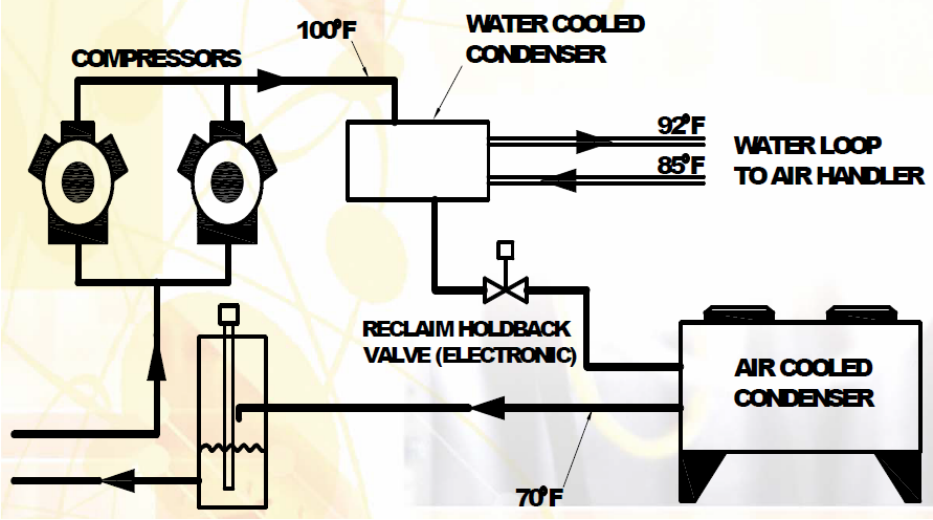
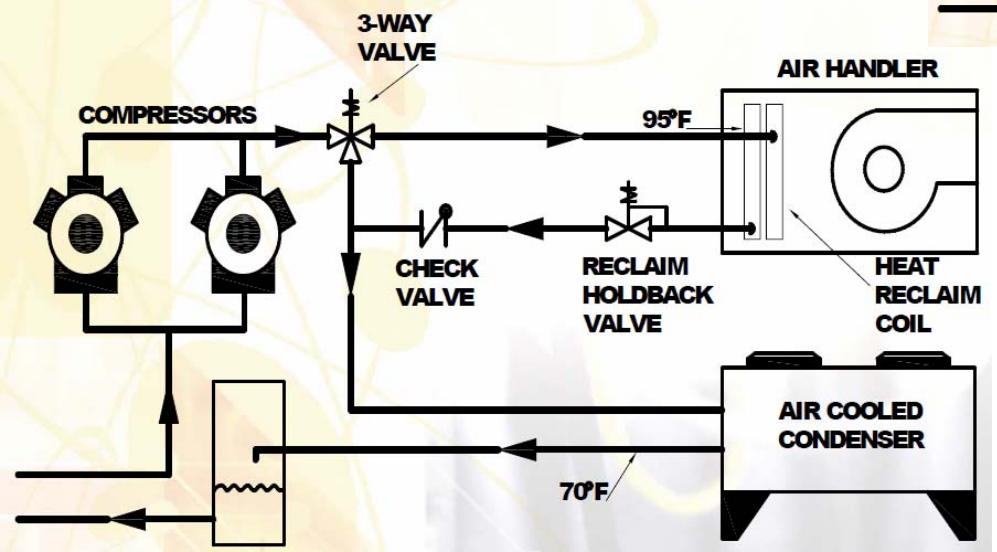
Refrigeration Heat Recovery



Indirect

Direct



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Refrigeration Heat Recovery

- Heat recovery from refrigeration and HVAC systems for space heating
  - ✓ At least 25% of Heat of Rejection for all refrigeration systems must be used for space heating
  - ✓ Heat recovery cannot use more than 20% additional HFC refrigerant charge, or 0.5 lbs per 1,000 Btuh of space heating capacity (whichever is less)

Energy & Charge Impacts

Commercial Refrigeration

Refrigeration Heat Recovery

	Measure Cost ($)	Refrigerant Cost Savings Range ($)		TDV Energy Cost Savings ($)	Carbon Cost Savings Range ($)		Net Savings Range ($)	
		High	Low		High	Low	High	Low
SXX Average	$21,396	-$2,414	-$3,956	$126,510	$1,233	-$9,435	$103,934	$91,722
MXX Average	$69,949	-$12,144	-$19,905	$478,112	-$17,192	-$70,876	$378,828	$317,383
LXX Average	$88,378	-$14,315	-$23,465	$540,915	-$24,105	-$89,836	$414,117	$339,236
XAX Average	$60,813	-$9,922	-$16,124	$336,229	-$20,096	-$63,813	$245,397	$195,479
XEX Average	$57,021	-$16,357	-$27,262	$371,734	-$61,883	-$138,755	$236,473	$148,697
XFX Average	$60,446	-$5,959	-$9,683	$432,518	$17,653	-$8,599	$383,766	$353,790
All Average								
Arcata	$59,908	-$9,624	-$15,775	$771,752	$44,374	$1,013	$746,594	$697,082
Oakland	$59,908	-$9,624	-$15,775	$545,607	$10,245	-$33,117	$486,320	$436,807
Santa Maria	$59,908	-$9,624	-$15,775	$568,282	$14,468	-$28,893	$513,219	$463,706
San Diego-Lindbergh	$59,908	-$9,624	-$15,775	$284,389	-$26,838	-$70,200	$188,019	$138,507
Fullerton	$59,908	-$9,624	-$15,775	$256,694	-$30,944	-$74,305	$156,219	$106,706
Riverside	$59,908	-$9,624	-$15,775	$257,436	-$31,391	-$74,753	$156,513	$107,001
Sacramento	$59,908	-$9,624	-$15,775	$399,091	-$12,284	-$55,646	$317,275	$267,762
Fresno	$59,908	-$9,624	-$15,775	$331,549	-$22,429	-$65,790	$239,589	$190,076
Palmdale	$59,908	-$9,624	-$15,775	$358,692	-$18,987	-$62,349	$270,173	$220,661
Palm Springs	$59,908	-$9,624	-$15,775	$44,962	-$59,755	-$103,117	-$84,324	-$133,837

Maximum Net Savings	$1,371,700	$1,353,583
Minimum Net Savings	-$283,217	-$416,070

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Commercial Refrigeration

Refrigeration Heat Recovery

(e) Refrigeration Heat Recovery

1. Refrigeration and HVAC systems shall utilize 25% or more of the design Heat of Rejection of all refrigeration systems for space heating.

2. The increase in HFC refrigerant charge ~~for~~ associated with refrigeration heat recovery shall be no greater than 20% of the total refrigerant charge without heat recovery, or 0.50 lbs per 1,000 BTU/Hr of heating capacity, whichever is less.

Commercial Refrigeration

Doors on Low Temp Display Cases

draft code language

Commercial Refrigeration

Doors on Low Temp Display Cases

2. Upright low temperature display cases that are designed for a supply air temperature of 5°F or lower shall utilize reach-in glass doors.

Commercial Refrigeration

Measures for 2017

- CO2 Cooling for Walk-ins & Display Cases
  - ✓ 2013 Reach Standard requirement
  - ✓ Secondary (indirect) cooling and/or cascade cooling
  - ✓ B/C range: 2-6 from GHG emission cost savings
- Evaporator Fan Variable Speed Controls
  - ✓ Lack of experience with this technology specifically in supermarket walk-ins
  - ✓ Concerns for product safety if walk-ins not designed to work well with reduced air flow
- Liquid Suction Heat Exchangers
  - ✓ Industry needs experience with heat exchangers that don't leak

Commercial Refrigeration

Proposed Measure Energy Efficiency Impacts

Commercial Refrigeration	Average Annual Energy Savings (kWh)	Annual TDV Cost Savings	Benefit / Cost Ratio
Recommended efficiency measures:			
Floating Head Pressure	78,174	$ 137,860	4.5
Condenser Specific Efficiency	5,229	$ 18,118	22.1
Floating Suction Pressure	30,446	$ 59,510	6.7
Mechanical Subcooling	32,889	$ 68,473	7.2
Display Case Lighting Control	123,995	$ 184,366	18.1
Heat Recovery for Space Heating	49,630	$ 23,086	6.3
Doors on Upright Low Temperature Cases	9,919	$ 22,789	no cost
Considered but not recommended:			
Evaporator Fan Variable Speed Control	57,750	$ 138,416	8.0
Liquid Suction Heat Exchangers	3,405	$ 7,363	3.5

Commercial Refrigeration

Acceptance Testing

- To be developed for all control-related measures
  - ✓ Floating Head Pressure Controls
  - ✓ Floating Suction Pressure Controls
  - ✓ Display Case Lighting Controls
  - ✓ Mechanical Subcooling
  - ✓ Heat Recovery

Commercial Refrigeration

Leak Reduction Measures

Background

- Refrigerant leaks are a significant source of greenhouse gas emissions
- Current Air Board regulations cover leak checking and leak repair requirements only, not system design/installation
- Good design and installation practices can significantly reduce refrigerant leak rates

Commercial Refrigeration

Leak Reduction Measures

- Measures address refrigeration system design and installation to minimize refrigerant leakage
- Based on ANSI, ASHRAE, IMC & stakeholder feedback
- Intended to set “floor”, not “ceiling” for stores >10,000 ft2
- No overlap with existing ARB regulations
- 12 draft proposed measures related to:
  - ✓ Piping & connections (#1- 3, 8, 12)
  - ✓ Valves (#4, 5, 6)
  - ✓ Corrosion prevention (#7)
  - ✓ Leak testing and monitoring (#9-11)

Commercial Refrigeration

Leak Reduction Measures

1. Welded refrigeration piping – not threaded
2. Copper tubing >= ¼” O.D.
3. No flare fittings
4. Pressure relief valves must have visual indicator for refrigerant release
5. Use only Schrader access valves with brass body
6. Valves shall have internal stem diaphragm or seal caps with chain tethers to fit over the stem
7. Evaporator coils in deli cases must be coated
8. Piping and components installed to protect from physical damage
9. Refrigerant piping shall be accessible for leak detection & repairs
10. Install level sensors on receivers with >= 200 pounds of refrigerant
11. Pressure test system during installation prior to evacuation & charging
12. Evacuate system following pressure testing & prior to charging

Commercial Refrigeration

Leak Reduction Measures

	Small Supermarket	Large Supermarket	Big Box Store
Cost/Store	$5,130	$6,980	$7,830
$/MTCO$_2$eq Reduction	+$13.18	-$1.33 (savings)	-$1.67 (savings)
Cost/Benefit Ratio	0.34	1.24	1.33
Simple Payback (years)	44*	12	11

* Exceeds life of equipment

- Savings due to reduced refrigerant usage
- Cost effectiveness increases as store size becomes larger
- Net cost to smaller stores; CO_2 reduction cost still considered moderate

Commercial Refrigeration

Leak Reduction Measures

- Full text of Leak Reduction Measures and Cost-Benefit analysis available at:
  - ✓ http://www.arb.ca.gov/cc/commref/commref.htmor
  - ✓ http://www.h-mg.com/T24/supermarket%20refrig/supermarketrefrig.htm

- Contact: Glenn Gallagher (ARB) at ggallagh@arb.ca.gov

Commercial Refrigeration

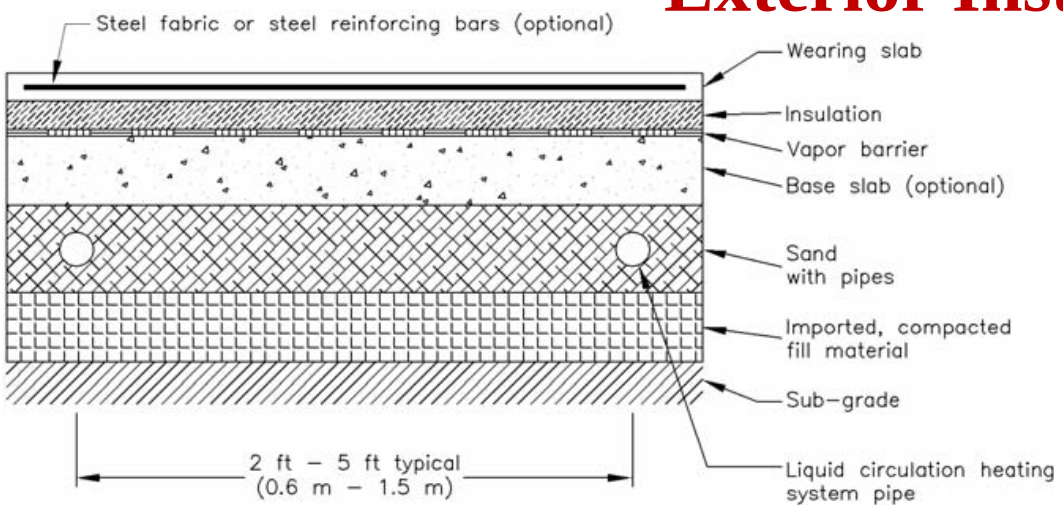
Refrigerated Warehouses

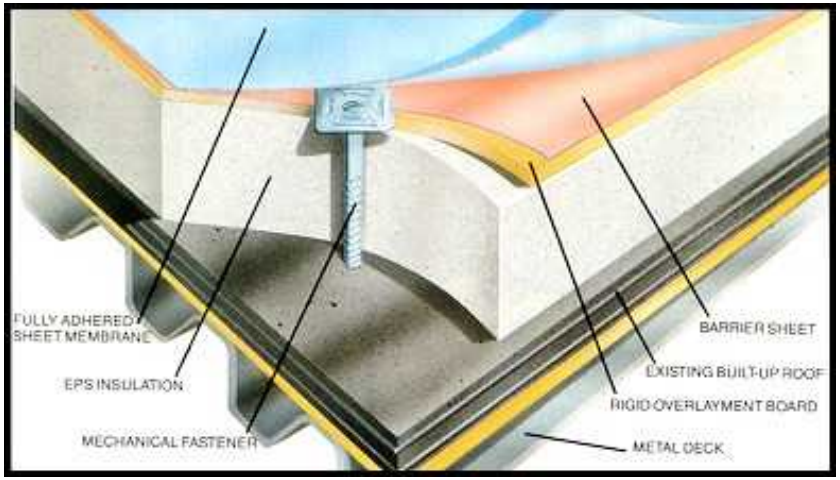
2013 Code Change Scope

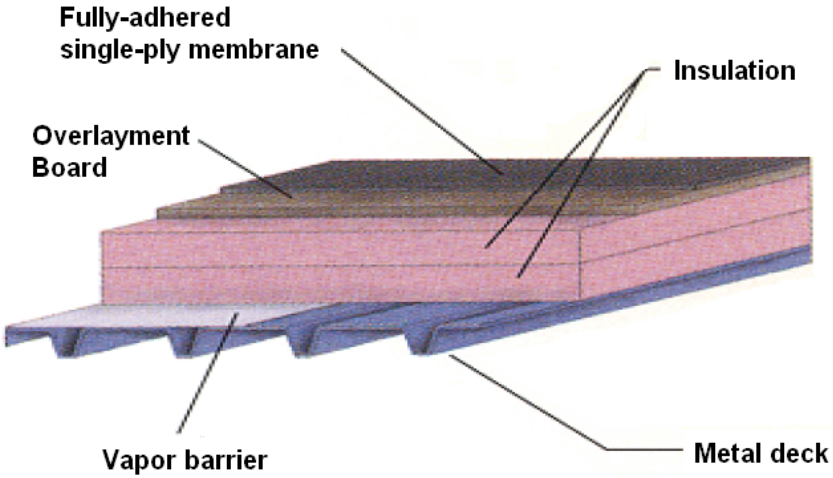
- Section 126 scope explanations
- Efficiency Requirements
  - ✓ Exterior Insulation
  - ✓ Evaporator Fans & Speed Controls
  - ✓ Condenser Design Temps
  - ✓ Condenser Fan Speed Controls
  - ✓ Condenser Specific Efficiency
  - ✓ Variable Speed Compressors
  - ✓ Infiltration Barriers
- Acceptance Testing

Refrigerated Warehouses

Exterior Insulation







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Refrigerated Warehouses

Exterior Insulation

a) Insulation Requirements. Exterior surfaces of refrigerated warehouses shall be insulated at least to the R-values in Table 126-A.

TABLE 126-A REFRIGERATED WAREHOUSE INSULATION

Space	Surface	Minimum R-Value (°F Hr ft^2/Btu)
Freezers ~~Frozen Storage~~	Roof/Ceiling	~~R-36~~ R-40
	Wall	R-36
	Floor	~~R-36~~ R-35
	Floor with all heating from productive refrigeration capacity*	R-20
Coolers ~~Cold Storage~~	Roof/Ceiling	R-28
	Wall	R-28

*If all subslab heating is provided by a heat exchanger that provides refrigerant subcooling or other means that results in productive refrigeration capacity on the associated refrigerated system.

Refrigerated Warehouses

Evaporators

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Refrigerated Warehouses

Evaporators

(c) Evaporators. Fan-powered evaporators used in coolers and freezers shall conform to the following:

1. Single phase fan motors less than 1 hp and less than 460 Volts shall be electronically commutated motors.

2. Evaporator fans served either by a suction group with multiple compressors, or by a single compressor with variable capacity capability shall be variable speed and the speed shall be controlled in response to space temperature or humidity. ~~conditions~~.

~~**EXCEPTION to Section 126 (c) 2:** Evaporators served by a single compressor without unloading capability.~~

3. Evaporator fans served by a single compressor that does not have variable capability shall utilize controls to reduce airflow by at least 40% for at least 75% of the time when the compressor is not running.

Refrigerated Warehouses

Condensers

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Refrigerated Warehouses

Condensers

(d) Condensers. Fan-powered condensers shall conform to the following:

~~1. Condensers for systems utilizing ammonia shall be evaporatively cooled.~~

Condition (SST/SCT)	NH_3			R-507		
	TR	HP	kW/TR	TR	HP	kW/TR
-20°F /100°F	76.8	193.8	1.982	70.6	233.7	2.60
20°F /100°F	203.3	253.7	0.980	179.3	282.8	1.24

- Allows ammonia to be used with air-cooled condensing
- No requirement to use air-cooled rather than evap-cooled condensers

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Refrigerated Warehouses
Condensers

1. Design saturated condensing temperatures for evaporative-cooled condensers ~~including but not limited to~~ and water-cooled condensers served by fluid coolers or cooling towers shall be less than or equal to:
   - The design wetbulb temperature plus 20°F in locations where the design wetbulb temperature is less than or equal to 76°F,
   - The design wetbulb temperature plus 19°F in locations where the design wetbulb temperature is between 76°F and 78°F, or
   - The design wetbulb temperature plus 18°F in locations were the design wetbulb temperature is greater than or equal to 78°F.

2. Design saturated condensing temperatures for air-cooled condensers ~~under design conditions~~ shall be less than or equal to the design drybulb temperature plus 10°F for systems serving ~~frozen storage~~ freezers and shall be less than or equal to the design drybulb temperature plus 15°F for systems serving coolers ~~cold storage~~.

   EXCEPTION to Section 126 (d) 2: ~~Unitary~~ Condensing units and chillers with a total compressor horsepower less than 100 HP.

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Refrigerated Warehouses
Condensers

3. All condenser fans for evaporative-cooled condensers or fans on cooling towers or fluid coolers shall be continuously variable speed, and the condensing temperature control system shall control the speed of all ~~condenser~~ fans serving a common condenser ~~loop~~ high side in unison. The minimum condensing temperature set point shall be less than or equal to 70°F.

4. All condenser fans for air-cooled condensers shall be continuously variable speed and the condensing temperature or pressure control system shall control the speed of all condenser fans serving a common condenser high side in unison. The minimum condensing temperature set point shall be less than or equal to 70°F~~, or reset in response to ambient drybulb temperature or refrigeration system load~~.

5. Condensing temperature reset. The condensing temperature set point of systems served by air cooled condensers shall be reset in response to ambient drybulb temperature. The condensing temperature set point of systems served by evaporative-cooled condensers or water-cooled condensers (via cooling towers or fluid coolers) shall be reset in response to ambient wetbulb temperatures.

EXCEPTION to Section 126 (d) 5: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide at least equal energy savings.

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Refrigerated Warehouses
Condensers

6. Fan-powered condensers shall meet the condenser efficiency requirements listed in Table 126-B. Condenser efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power including fan power at 100% fan speed, and power of spray pumps for evaporative condensers.

TABLE 126-B FAN-POWERED CONDENSERS – MINIMUM EFFICIENCY REQUIREMENTS

Condenser Type	Refrigerant Type	Minimum Efficiency	Rating Condition
Outdoor Evaporative-Cooled with THR Capacity > 8,000 MBH	All	350 Btuh/Watt	100°F Saturated Condensing Temperature (SCT), 70°F Outdoor Wetbulb Temperature
Outdoor Evaporative-Cooled with THR Capacity < 8,000 MBH and Indoor Evaporative-Cooled	All	160 Btuh/Watt	
Outdoor Air-Cooled	Ammonia	75 Btuh/Watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
	Halocarbon	65 Btuh/Watt	
Indoor Air-Cooled	All	Exempt	

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Refrigerated Warehouses
Condensers

6. ~~All single phase condenser fan motors less than 1 hp and less than 460 V shall be either permanent split capacitor or electronically commutated motors~~.

7. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION to Section 126 (d) 7: Micro-channel condensers.

Refrigerated Warehouses

Compressors

draft code language

Refrigerated Warehouses

Compressors

(e) Compressors. Compressor systems utilized in refrigerated warehouses shall conform to the following:

1. Compressors shall be designed to operate at a minimum condensing temperature of 70°F or less.

2. ~~The compressor speed of~~ An open-drive screw compressor with a design saturated suction temperature (SST) of 28°F or lower and that discharges to the system condenser pressure ~~greater than 50 hp~~ shall ~~be controllable~~ control compressor speed in response to the refrigeration load ~~or the input power to the compressor shall be controlled to be less than or equal to 60 percent of full load input power when operated at 50 percent of full refrigeration capacity~~.

EXCEPTION 1 to Section 126 (e) 2: Refrigeration plants with more than one dedicated compressor per suction group.

3. Screw compressors with nominal electric motor power greater than 150 hp shall include the ability to automatically vary the compressor volume ratio (Vi) in response to operating pressures.

Refrigerated Warehouses

Infiltration Barriers

draft code language

Refrigerated Warehouses
Infiltration Barriers

(f) Infiltration Barriers. Passageways between freezers and higher-temperature spaces, and passageways between coolers and non-refrigerated spaces shall have an infiltration barrier consisting of strip curtains, an automatically-closing door or air curtain designed by its manufacturer for use in the passageway and temperature for which it is applied.

EXCEPTION 1 to Section 126 (f): Openings with less than 16 SF of opening size.

EXCEPTION 2 to Section 126 (f): Dock doorways for trailers.

Refrigerated Warehouses

Acceptance Testing

- Refrigeration System Acceptance for:
  - ✓ Electric Resistance Under-slab Heating System
  - ✓ Evaporators and Evaporator Fan Motor Variable Speed Control
  - ✓ Evaporative Condensers and Condenser Fan Motor Variable Speed Control
  - ✓ Air-cooled Condensers and Condenser Fan Motor Variable Speed Control
  - ✓ Variable Speed Screw Compressors
- Test components: construction inspection & functional testing

Refrigerated Warehouses

2013 Standards Update

Please send comments on today's workshop topics by April 25, 2011 to:

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