How to Meet 2017/2020 Energy Efficiency and Refrigerant Regulations

U.S. Commercial Foodservice
September 3, 2015

Allen Wicher & Ani Jayanth
Emerson Climate Technologies
Balancing Four Basic Variables to Solve Customers’ Needs

DOE Regulations Require New System Designs

% Efficiency

Now Reach-in '17
Now Ice '18
Now Walk-in '20

-35%
-17%
-37%

Component Electronics Are a Larger Spend

% of Top 50 Retailers Testing Refrigerant Alternatives

0% 20% 40% 60% 80% 100%

2010 2015

6% 83%

C-Stores Targeting Foodservice for Growth

Sales % Margin %

100%
80%
60%
40%
20%
0%

Food & Bev.
Fuel & Tobacco
Other

Economics Equipment

Component Electronics Are a Larger Spend

$K

HFC CO₂

Optional Electronics Mechanical

Food & Bev.

Now '17
Now '18
Now '20

17% 15%

Now '17
Now '18
Now '20

17% 15%

37% 35%

37% 35%

Now '17
Now '18
Now '20

17% 15%
Refrigerant and Minimum Energy Efficiency Regulations Require Industry to Balance the Equation

- Reduce energy consumption with optimized refrigeration equipment system performance.
- Ensure EPA compliance and reduce GWP with refrigerant choices that minimize impact to equipment performance.
- Preserve reliability, serviceability and safety. Understand the toxicity, flammability and pressure implications.
- Estimate the total cost of ownership and viability of technology changes.

Best Solution for End User
# Status of U.S. Refrigeration Energy Regulations

<table>
<thead>
<tr>
<th>Product Class</th>
<th>Current</th>
<th>NOPR</th>
<th>Final</th>
<th>Effective</th>
<th>Energy Level Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed-door Reach-in (Self-contained)</td>
<td>2010</td>
<td>Oct. 2013</td>
<td>March 2014*</td>
<td>March 2017</td>
<td>kWh/Day 30% – 50%</td>
</tr>
<tr>
<td>Ice Maker</td>
<td>2010</td>
<td>NODA Sept. 2014</td>
<td>Jan. 2015</td>
<td>Jan. 2018</td>
<td>kWh/100 lbs 5% – 15%</td>
</tr>
<tr>
<td>Walk-In (Foodservice)</td>
<td>2009</td>
<td>Sept. 2013</td>
<td>Jan. 2016**</td>
<td>Jan. 2020</td>
<td>AWEF 20% – 40%; LT &amp; Multiplex TBD %</td>
</tr>
<tr>
<td>Supermarket</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Competency California Title 24 Effective July 2014</td>
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</tbody>
</table>

Building Energy Alliance Challenge Spec in Process
ASHRAE 90.1 Advanced Energy Design Guideline in Process
Canada Supermarket Minimum Efficiency Std. in Process

* Lawsuit filed by industry in 7th Circuit Court; DOE response filed 7/22/15, NAFEM reply due 8/19/15
** Lawsuit filed by industry in 5th Circuit Court; settlement reached July 2015 in setting standards (still requires 5th Circuit Court approval)
## EPA’s Final Rule

### Phase-out dates / Likely alternatives

**Summary of most commonly used refrigerants**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MT, &lt;2,200 BTU/hr. and no flooded evap. New</td>
<td>MT, &gt;2,200 BTU/hr. or contain flooded evap. New</td>
</tr>
<tr>
<td>R-410A</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>-</td>
<td>2019</td>
<td>2020</td>
</tr>
<tr>
<td>R-407A/C/F</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>2019</td>
<td>2020</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>2019</td>
<td>2020</td>
</tr>
</tbody>
</table>

**Likely Alternatives**

<table>
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<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Neither SNAP-approved, nor banned</td>
<td>Neither SNAP-approved, nor banned</td>
</tr>
<tr>
<td>R-448A/449A</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>R-450A/513A</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>R-290</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>R-744</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>R-717</td>
<td>OK (in primary loop of secondary CO₂ sys.)</td>
<td>-</td>
<td>OK (in primary loop of secondary CO₂ sys.)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Includes ice machines connected to a supermarket rack refrigeration system.

** EPA uses term “retrofit” to indicate the use of a refrigerant in an appliance that was designed for and originally operated using a different refrigerant. Term does not apply to upgrades to existing equipment where the refrigerant is not changed.
Refrigerant Limitations

• R-448A/449A Approval for Stand-alone MT Required

• R-448A/449A for Reciprocating Hermetic
  – LT envelope challenges due to high heat of compression
  – Glide considerations
  – Capacity increases from R-404A

• R-450A/513A for Reciprocating Hermetics
  – R-450A capacity drops from 134a
  – R-513A near drop in replacement with no theoretical capacity changes
  – Glide considerations
  – MBP to LBP performance drops and capacity changes, requiring complete system redesign
## DOE Potential Impact to Channel

<table>
<thead>
<tr>
<th></th>
<th>Equipment Mfg.</th>
<th>Contractors</th>
<th>Design Consultants, Mfg. Reps, Dealers</th>
<th>End Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Equip. Cost Adder</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Footprint Increase and Space Management</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3. Equipment Architecture Change</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4. System Architecture Change</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5. Inventory and Existing Stock Sell Thru Provision Mgmt.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Compliance Approval Mgmt.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Service Training and Equipment Availability (New Equipment Cross-Reference)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Equipment Performance &amp; Product Reposition &amp; Consolidation</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>9. Installation Changes and Retrofit Frequency</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Equipment Operation and User Interface Differences</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>11. New Maintenance Training</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
DOE Energy Regulations Impact by Application

Ani Jayanth

Emerson Climate Technologies, Inc.
DOE Equipment Regulations Survey

Commercial Refrigeration Equipment

- Effective March 2017 on New Equipment
- CRE Measured in kWh/24-Hour Day
  - Each equipment class assigned equation
  - Variable: Total Display Area (TDA) or volume

Walk-in Coolers and Freezers (WICF)

- Effective January 2020 on New Equipment
- WICF Measured in Three Major Components
- AWEF Measured Using AHRI-1250 Testing Standard
  - Each equipment class assigned equation
  - Variable: \( Q \) = system capacity

Automatic Commercial Ice Makers

- Effective January 2018 on New Equipment
- ACIM Measured in kWh/100 lbs Ice
  - Each equipment class assigned equation
  - Variable: \( H \) = harvest rate in lbs per 24 hours

From 20% to 50% Energy Reduction Required for Systems, Depending on Class

5% to 25% Energy Reduction Required

Source: Department of Energy
Commercial Refrigeration Equipment

Equipment Classes

- Low- or Medium-Temperature
- Vertical, Semi-Vertical, Horizontal or Service Over Counter
- Self-contained or Remote Condensing
- With or Without Solid/Transparent Doors
- Commercial Refrigerator and Freezer

Equipment Affected

No Energy Conservation Standards and Test Procedures
Salad Bars, Prep Tables, Refrigerated Buffet Tables

HOWEVER...
If There Is a Reach-in Under Them, Waiver From DOE Must Be Requested

Source: Department of Energy
CRE Regulation Exceptions

- Currently No Test Procedures for *Certain* Styles of Equipment
- Based on Power Supply and the Sharing/Non-Sharing of Refrigeration System for Both Top and Bottom
- If Criteria Met, OEM’s Can Apply for Waiver Based on Architecture
- Contact DSN for Answers on Specific OEM-related Questions on Exceptions

**Top Rail**
Refrigerated Cold Wall or Forced Air

**Bottom Storage**
Refrigerated or Non-refrigerated

Salad Bars, Chef Bases, Griddle Stands, Frost Tops, Buffet, Prep
## CRE Prep and Buffet Table Architectures and Compliance Note

<table>
<thead>
<tr>
<th>Top Rail</th>
<th>Bottom Storage</th>
<th>Certification Required</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>No Power Supplied or From Common Supply With Top</td>
<td>See Refrigeration Requirements</td>
<td>Single Energy Source</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Power Supply</td>
<td>Yes</td>
<td>Dual Energy Source With Single Source Requirement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Top Rail</th>
<th>Bottom Storage</th>
<th>Certification Required</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated: Cold Wall or Forced Air</td>
<td>Dry: Non-Refrigerated</td>
<td>No</td>
<td>Regular Buffet/Prep Construction — No Classification</td>
</tr>
<tr>
<td>Refrigerated: Cold Wall or Forced Air With Heat Being Rejected Directly Into Lower Section</td>
<td>Refrigerated: Air in Lower Section Coming in Direct Contact With Top Rail, and Single Condensing Unit</td>
<td>No</td>
<td>Heat From Upper Rail Is Being Absorbed Directly Into Lower Section Refrigeration System With Single Energy Source and Single Refrigeration System</td>
</tr>
<tr>
<td>Refrigerated: Cold Wall or Forced Air With No Direct Contact With Lower Section</td>
<td>Refrigerated: Cold Wall or Forced Air With No Direct Contact With Rail Section, and Single Condensing Unit</td>
<td>Yes</td>
<td>Heat From Upper Rail Is Not Being Absorbed Directly Into Lower Section Refrigeration System With Single Energy Source and Single Refrigeration System</td>
</tr>
<tr>
<td>Refrigerated: Cold Wall or Forced Air With Its Own Condensing Unit</td>
<td>Refrigerated: Cold Wall or Forced Air With Its Own Condensing Unit</td>
<td>Yes</td>
<td>Dual Refrigeration System With Single Refrigeration System Requirement, Single or Dual Energy Source</td>
</tr>
</tbody>
</table>
Commercial Refrigeration Equipment
Design Option vs. Cost

kWh/Day = Comp. Energy Draw + Lighting + Fan + Controls + Others

Total System Measurement Based on Equipment Type
CDU Is Treated as Component

Source: Department of Energy
Walk-in Coolers and Freezers (WICF)

Equipment Classes

- **Dedicated**
  - Single walk-in feed
  - A packaged dedicated system where the unit cooler and condensing unit are integrated into a single piece of equipment
  - A split dedicated system with separate unit cooler and condensing unit sections

- **Multiplex**
  - Unit coolers matched to multiplex condensing rack system

Source: Department of Energy
DOE WICF Regulation Changes

July 30, 2015

<table>
<thead>
<tr>
<th>Dedicated/Multiplex Condensing</th>
<th>Original</th>
<th>Challenge</th>
<th>Suggested Compression Compliance Guidance</th>
<th>Settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT Walk-in Freezer</td>
<td>June 2017</td>
<td>• DOE Setting Internally Inconsistent Standards That Were Unachievable Using Economically Feasible Technologies • Flowed Cost Benefit Work • Failed Analysis of Small Business Impacts • DOE Court Order Necessary to Make Changes</td>
<td>Vapor-injected Scroll Floating Head Pressure</td>
<td>• LT Dedicated &amp; Multiplex Systems Vacated &amp; Committee Re-work Due Jan. 2016 and Expected Final Rule Jan. 2017</td>
</tr>
</tbody>
</table>
Walk-in Coolers and Freezers (WICF)
Compression Technology Survey for AWEF

- **MT**
  - R-404A

- **LT**

**EER**
- **Scroll Digital**
  - ~3–10% Effy. (~9–24% cum.)
  - w/Floating Head Pressure & EXV
  - ~6–14% Effy.

- **Scroll Variable Speed**
  - ~TBD

- **Scroll Variable Speed**
  - ~2% Effy. — Full Load TBD (~25–33% cum.)

- **Scroll Vapor Injection & Digital**
  - ~13–16% Effy. (~23–31% cum.)

- **Recip**
  - ~2% Effy. — Full Load TBD (~25–33% cum.)
  - w/Floating Head Pressure & EXV
  - ~6–14% Effy.

- **Recip**
  - ~10–15% Effy.

**Applied Cost**
- **Scroll**
  - w/Floating Head Pressure & EXV
  - ~10–15% Effy.

- **Scroll Variable Speed**
  - w/Floating Head Pressure & EXV
  - ~TBD

- **Scroll Vapor Injection & Digital**
  - w/Hot Gas Defrost & Additional Coil
  - ~13–16% Effy. (~23–31% cum.)

- **Recip**
  - w/Hot Gas Defrost & Additional Coil
  - ~2% Effy. — Full Load TBD (~25–33% cum.)

*Directional Intent Only*
Automatic Commercial Ice Makers

Overview

• Affecting **Batch** Ice Machines Also Known as “Cubers”
• Affecting **Continuous** Ice Machines Also Known as “Flakers” or “Nuggets”

- **Cuber Modular**
- **Cubers Self-contained**
- **Flakers**
- **Nugget**
- **Hotel Dispensers**

- **Air- or Water-cooled**
- **Self-contained or Remote Condensing**
- **Various Harvest Rates**

• **Frozen Carbonated Beverage Machines Not Affected**
## Automatic Commercial Ice Makers
### Design Options

<table>
<thead>
<tr>
<th>Technology Options</th>
<th>Batch</th>
<th>Continuous</th>
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</thead>
<tbody>
<tr>
<td><strong>Compressor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved EER</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Part Load Operation</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>Condenser</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased Surface Area</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Enhanced Fins Surfaces</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Increased Air and Water Flows</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Brazed Plate or Micro Channel Coil</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECM Condenser Fan</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Improved Auger Motor</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Improved Pump Motor</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td><strong>Evaporator</strong></td>
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<td></td>
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<tr>
<td>Reduced Energy Loss From Thermal Cycling</td>
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<tr>
<td>Reduced Harvest Time</td>
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<tr>
<td><strong>Other</strong></td>
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<tr>
<td>Thicker Insulation</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Reduced Potable Water Flow</td>
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<td></td>
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</tbody>
</table>

*Source: Department of Energy*
Thank You!

Questions?

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