Staying Ahead of the DOE 2017 Walk-In Cooler and Freezer Energy Efficiency Ratings

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Presented By:

Ani Jayanth
Foodservice Marketing Manager
Emerson Climate Technologies

Brian Buynacek, PE, LEED AP
Refrigeration Engineer
Emerson Climate Technologies
Webinar Objectives

- **WICF & AWEF Rulemaking Overview:**
  - Ani Jayanth
  1. Understand WICF rulemaking
  2. Understand specifics of TSD
  3. Understand cost-efficiency design options

- **Alternative Refrigerants Note:**
  - Ani Jayanth

- **AWEF Calculation & Technology Guidance:**
  - Brian Buynacek
  1. AWEF for indoor and outdoor condensing units
  2. BIN temperature analysis
  3. AWEF minimums for 2017
  4. Differences between AHRI 1250 and DOE interpretation
  5. Importance of floating head pressure
  6. Example pass/fail calculations
WICF & AWEF Rulemaking Overview

Ani Jayanth

- **WICF & AWEF Rulemaking Overview**
  1. Understand WICF rulemaking
  2. Understand specifics of TSD
  3. Understand cost-efficiency design options
## Definitions

| Walk-in Cooler and Freezer (WICF) | The Energy Policy and Conservation Act (EPCA) defines “walk-in cooler” and “walk-in freezer” as **an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 °F that can be walked into**, and has a total chilled storage area of less than 3,000 ft². The definition excludes products designed and marketed exclusively for medical, scientific or research purposes. (42 U.S.C. 6311[20]) |
| Notice of Public Rulemaking (NOPR) | Federal document released to inform parties of intentions of altering or offering new rulemaking |
| Supplemental Notice of Public Rulemaking (SNOPR) | Further information collected from stakeholders and additional supporting information attached to original NOPR |
| Final Rule | Federal document released to inform stakeholders of new mandated regulatory compliance standards |
| Technical Support Document (TSD) | Document released to justify rulemaking with engineering and economic analyses |
| Trial Standard Level (TSL) | The level adopted for final rule which determines the acceptable energy efficiency with respect to operational and capital costs |
| Annual Walk-in Energy Factor (AWEF) | Ratio of heat removed from the envelope to the total energy input of the refrigeration system |

Source: Department of Energy
<table>
<thead>
<tr>
<th></th>
<th>Type</th>
<th>Description</th>
<th>Key Piece of Information in Relation to AWEF</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Final Rule</td>
<td>Summary of rulemaking, TSD, test procedure and framework for understanding and rulemaking</td>
<td>Table I.1</td>
<td><a href="http://www.regulations.gov/docketDetail/D-EERE-2008-0141">http://www.regulations.gov/docketDetail/D-EERE-2008-0141</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Table V.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Table V.47</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chapter 7 – Refrigeration Energy Use</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Final Rule Engineering Analysis Refrigeration Spreadsheet</td>
<td>XLS spreadsheet with all components related to determining AWEF for the refrigeration system and content loaded from TSD</td>
<td>Calculation Tab</td>
<td><a href="http://www.regulations.gov/docketDetail/D-EERE-2008-0141">http://www.regulations.gov/docketDetail/D-EERE-2008-0141</a></td>
</tr>
</tbody>
</table>
A Note on Technical Support Document
Research & Analysis

- Ernest Orlando Lawrence Berkeley National Laboratory
- Navigant Consulting, Inc.

Table 1.4.1 Analyses Under the Process Rule

<table>
<thead>
<tr>
<th>Preliminary Analyses</th>
<th>NOPR</th>
<th>Final Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market and technology assessment</td>
<td>Revised preliminary analyses</td>
<td>Revised NOPR analyses</td>
</tr>
<tr>
<td>Screening analysis</td>
<td>Life-cycle cost sub-group analysis</td>
<td></td>
</tr>
<tr>
<td>Engineering analysis</td>
<td>Manufacturer impact analysis</td>
<td></td>
</tr>
<tr>
<td>Markups for equipment price determination</td>
<td>Environmental assessment</td>
<td></td>
</tr>
<tr>
<td>Life-cycle cost and payback period</td>
<td>Employment impact analysis</td>
<td></td>
</tr>
<tr>
<td>Shipment analysis</td>
<td>Regulatory impact analysis</td>
<td></td>
</tr>
<tr>
<td>National impact analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary manufacturer impact analysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- September 2013
  - NOPR
- February 2014
  - SNOPR
- April 2014
  - Public Commentary Extension
- June 2014
  - Final Rule
- June 5, 2017
  - Compliance

Source: Department of Energy
Refrigeration System Classification

Dedicated Condensing

- Refrigeration system means the mechanism (including all controls and other components integral to the system's operation) used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of any of the following:
  - Indoor/outdoor
  - 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

Source: Department of Energy
Refrigeration System Classification

Multiplex Condensing

- Refrigeration system means the mechanism (including all controls and other components integral to the system’s operation) used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of any of the following:
  - Unit Coolers Matched To Multiplex Condensing Rack System

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**Table 5.3.5 Analysis Points: Multiplex Condensing Refrigeration Systems**

<table>
<thead>
<tr>
<th>Condensing Type</th>
<th>Temperature</th>
<th>Class Code</th>
<th>Number of Fans per Inch</th>
<th>Capacity (Btu/h)</th>
<th>Number of Fans</th>
<th>Analysis Point Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Condensing</td>
<td>Medium</td>
<td>MC.M</td>
<td>6</td>
<td>4,000</td>
<td>1</td>
<td>MC.M.N.005.004.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>9,000</td>
<td>2</td>
<td>MC.M.N.005.009.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>24,000</td>
<td>6</td>
<td>MC.M.N.006.024.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>4,000</td>
<td>1</td>
<td>MC.M.N.004.004.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>9,000</td>
<td>2</td>
<td>MC.M.N.004.009.2</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>MC.L</td>
<td>6</td>
<td>4,000</td>
<td>1</td>
<td>MC.L.N.006.004.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>9,000</td>
<td>2</td>
<td>MC.L.N.006.009.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>18,000</td>
<td>2</td>
<td>MC.L.N.006.018.2</td>
</tr>
<tr>
<td></td>
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<td>4</td>
<td>4,000</td>
<td>1</td>
<td>MC.L.N.004.004.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>9,000</td>
<td>2</td>
<td>MC.L.N.004.009.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>18,000</td>
<td>2</td>
<td>MC.L.N.004.018.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>40,000</td>
<td>2</td>
<td>MC.L.N.004.040.2</td>
</tr>
</tbody>
</table>

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Source: Department of Energy
Standards for WICF

1. Cost Model
   • Market baseline information
   • Material, labor, depreciation, other costs

2. Energy Model
   • Existing technology assessment
   • Technology options from screening analysis
   • Energy consumption model
     – Output of energy model: cost-efficiency curve for each equipment class and for each component analyzed

Maximum Energy Consumption (MEC) for Doors
R-Value for Panels
AWEF Walk-in Refrigeration System (subject of webinar)

“…shall be designed to achieve the maximum improvement in energy efficiency that DOE determines is both technologically feasible and economically justified…the new or amended standard must result in the significant conservation of energy.”

Source: Department of Energy
Final Rule Methodology

**Dedicated Condensing & Multiplex Condensing**

1. **Table V.10—AWEFs for All Refrigeration System TSLs**

<table>
<thead>
<tr>
<th>Equipment class</th>
<th>Baseline</th>
<th>TSL 1</th>
<th>TSL 2</th>
<th>TSL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC.M.I, &lt;9,000</td>
<td>3.51</td>
<td>5.61</td>
<td>5.61</td>
<td>5.61</td>
</tr>
<tr>
<td>DC.M.I, ≥9,000</td>
<td>3.51</td>
<td>6.99</td>
<td>7.60</td>
<td>7.60</td>
</tr>
<tr>
<td>DC.M.O, &lt;9,000</td>
<td>3.14</td>
<td>6.99</td>
<td>7.60</td>
<td>7.60</td>
</tr>
<tr>
<td>DC.M.O, ≥9,000</td>
<td>3.14</td>
<td>6.99</td>
<td>7.60</td>
<td>7.60</td>
</tr>
<tr>
<td>DC.L.I, &lt;9,000</td>
<td>2.23</td>
<td>2.78</td>
<td>3.10</td>
<td>3.10</td>
</tr>
<tr>
<td>DC.L.O, &lt;9,000</td>
<td>0.82</td>
<td>1.29</td>
<td>2.73</td>
<td>2.73</td>
</tr>
<tr>
<td>DC.L.I, ≥9,000</td>
<td>2.57</td>
<td>4.17</td>
<td>4.79</td>
<td>4.79</td>
</tr>
<tr>
<td>MC.M</td>
<td>6.11</td>
<td>10.89</td>
<td>10.89</td>
<td>10.89</td>
</tr>
<tr>
<td>MC.L</td>
<td>3.29</td>
<td>5.56</td>
<td>6.57</td>
<td>6.57</td>
</tr>
</tbody>
</table>

*Q* represents the system gross capacity as calculated in AHRI 1250.

2. **Table I.1—Energy Conservation Standards for Walk-In Coolers and Walk-In Freezers**

<table>
<thead>
<tr>
<th>Class descriptor</th>
<th>Class</th>
<th>Standard level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated Condensing, Medium Temperature, Indoor System, &lt;9,000 Btu/h Capacity</td>
<td>DC.M.I, &lt;9,000</td>
<td>Minimum AWEF (Btu/h) *</td>
</tr>
<tr>
<td>Dedicated Condensing, Medium Temperature, Indoor System, ≥9,000 Btu/h Capacity</td>
<td>DC.M.I, ≥9,000</td>
<td>5.61</td>
</tr>
<tr>
<td>Dedicated Condensing, Medium Temperature, Outdoor System, &lt;9,000 Btu/h Capacity</td>
<td>DC.M.O, &lt;9,000</td>
<td>7.60</td>
</tr>
<tr>
<td>Dedicated Condensing, Medium Temperature, Outdoor System, ≥9,000 Btu/h Capacity</td>
<td>DC.M.O, ≥9,000</td>
<td>7.60</td>
</tr>
<tr>
<td>Dedicated Condensing, Low Temperature, Indoor System, &lt;9,000 Btu/h Capacity</td>
<td>DC.L.I, &lt;9,000</td>
<td>Minimum AWEF (Btu/h) *</td>
</tr>
<tr>
<td>Dedicated Condensing, Low Temperature, Outdoor System, &lt;9,000 Btu/h Capacity</td>
<td>DC.L.I, &lt;9,000</td>
<td>5.93 × 10^-5 × Q + 2.33</td>
</tr>
<tr>
<td>Dedicated Condensing, Low Temperature, Indoor System, ≥9,000 Btu/h Capacity</td>
<td>DC.L.I, ≥9,000</td>
<td>3.10</td>
</tr>
<tr>
<td>Dedicated Condensing, Low Temperature, Outdoor System, ≥9,000 Btu/h Capacity</td>
<td>DC.L.O, ≥9,000</td>
<td>Minimum AWEF (Btu/h) *</td>
</tr>
<tr>
<td>Multiplex Condensing, Medium Temperature</td>
<td>MC.M</td>
<td>10.89</td>
</tr>
<tr>
<td>Multiplex Condensing, Low Temperature</td>
<td>MC.L</td>
<td>6.57</td>
</tr>
</tbody>
</table>

3. **Equation**

\[ Q = \text{system gross capacity} \]

Source: Department of Energy
Meeting AWEF

Example: *Dedicated Condensing-Low Temp-Outdoor-Scroll-54K Btu/H*

Source: Department of Energy
## DOE Design Options to Meet AWEF Summary

<table>
<thead>
<tr>
<th>Option</th>
<th>DC Outdoor LT/MT</th>
<th>DC Indoor LT/MT</th>
<th>MC LT/MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Floating Head Pressure</td>
<td>Modulating Evaporator Fans</td>
<td>Modulating Evaporator Fans</td>
</tr>
<tr>
<td>2</td>
<td>Floating Head Pressure With Electronic Expansion Valve</td>
<td>Variable Speed Evaporator Fans</td>
<td>Variable Speed Evaporator Fans</td>
</tr>
<tr>
<td>3</td>
<td>Modulating Evaporator Fans</td>
<td>Improved Coil</td>
<td>Improved Evaporator Fan Blades</td>
</tr>
<tr>
<td>4</td>
<td>Electronically Commutated Motors</td>
<td>Improved Condenser Fan Blades</td>
<td>Temperature-initiated, Temperature-terminated Defrost</td>
</tr>
<tr>
<td>5</td>
<td>Improved Evaporator Fan Blades</td>
<td>Electronically Commutated Motors</td>
<td>Hot Gas Defrost</td>
</tr>
<tr>
<td>6</td>
<td>Improved Condenser Fan Blades</td>
<td>Improved Evaporator Fan Blades</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Improved Coil</td>
<td>Temperature-initiated, Temperature-terminated Defrost</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hot Gas Defrost</td>
<td>Hot Gas Defrost</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Temperature-initiated, Temperature-terminated Defrost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Variable Speed Compressor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Variable Speed Condenser Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Variable Speed Evaporator Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Ambient Sub-cooling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Energy
Polling Question #1

What part of the refrigeration will you place the most importance on for improvement to meet AWEF?

a. Compressor
b. Condenser coil
c. Condenser fan motors
d. Controls
e. Defrost
f. Evaporator coil
g. Evaporator fan motors
In 2013 and early 2014, the EPA held stakeholder meetings to get input on which HFCs, if any, could be delisted.

The NOPR to delist was published on August 6
- Comments due on October 20

Making Sense Webinar on Refrigerants

Links to documents on the EPA website:
## EPA’s Proposed Rule on Delisting HFCs by Application

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Supermarket*</th>
<th>Condensing Units* (field charged)</th>
<th>Standalone Self Contained Comm. Ref. Eqpt* (factory charged sealed systems)</th>
<th>Vending Machines*</th>
<th>Foam</th>
<th>Auto AC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Sec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R407A, R407F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jan 2016 (New)</td>
</tr>
<tr>
<td>R134a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2021 Model (New)</td>
</tr>
<tr>
<td>Various Blends, GWP 600-3990**</td>
<td></td>
<td></td>
<td>Jan 2016 (New)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Various Foam Refs**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jan 2017</td>
</tr>
<tr>
<td>Various Auto Blends**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2017 Model (New)</td>
</tr>
</tbody>
</table>

* New And Retrofit Only; Service Is Allowed  
** Check EPA Documents For Details  
Aerosol Application Not Shown In Above Table  
Industrial, Ice Making Heads, Warehouses and Transport Applications Are Not Included In This NOPR But Comments Have Been Requested
Refrigerant Options for Air Conditioning and Refrigeration Applications

Pressure or Capacity

R-410A Like

R32/HFO Blends

R404A & R407/22 Like

NH₃

<300

R450A = N13

HFO 1234zf

~600

R513A* = XP10

R134a Like

HFO 1234yf

~300

R444B = L20

L40, DR7

HFC/HFO Blends

R446A, R447A,

R32

400-675

R32/HFO Blends

<150

HDR110

ARM20

R22

R407A

R407C

R407F,

R452A* = XP44

ARM35

R410A

R404A/507A

(3922)

* Pending ASHRAE final approval

Qualitative Chart – Not to Scale
## Emerson View on Available Options (Not a Comprehensive List)

<table>
<thead>
<tr>
<th>Retail Food Refrigeration</th>
<th>Today</th>
<th>Alternates Today</th>
<th>Future Alternative(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supermarket</strong></td>
<td>R404A/R507A</td>
<td>R407A/F*</td>
<td>R448A*, R449A*</td>
</tr>
<tr>
<td><strong>Condensing Unit</strong> (field charged)</td>
<td>R404A/R507A</td>
<td>R407A/F*</td>
<td>R448A*, R449A*</td>
</tr>
<tr>
<td><strong>Standalone Self Contained Comm. Ref. Eq.</strong></td>
<td>R404A/R507A</td>
<td>R290***</td>
<td>R448A(?), L40**,</td>
</tr>
<tr>
<td><strong>(factory charged sealed systems)</strong></td>
<td>R134a</td>
<td>R290*</td>
<td>R449A(?), DR7**,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HDR-110**, ARM20**</td>
</tr>
</tbody>
</table>

* May Have Disch. Temp Issues For Compressor
** A2L – Mildly Flammable
*** A3 – Highly Flammable

? – Some Clarifications Required From EPA
1 – Total System Redesign Required

Source: Emerson Climate Technologies
Polling Question #2

Before seeing the last several slides, how clear were you on the DOE’s Final Rule on AWEF?

a. Very clear
b. Clear
c. Somewhat clear
d. I did not know about them
AWEF Calculation & Technology Guidance

Brian Buynacek

- AWEF Calculation & Technology Guidance
  1. AWEF for indoor and outdoor condensing units
  2. BIN temperature analysis
  3. AWEF minimums for 2017
  4. Differences between AHRI 1250 and DOE interpretation
  5. Importance of floating head pressure
  6. Example pass/fail calculations
What Is AWEF?

- Ratio of heat removed from the envelope to the total energy input of the refrigeration system
- Metric based on efficiency rather than energy use because of walk-in system sizing and heat load produced
- Assumption that the system is sized appropriately to the load, regardless of envelope characteristics

**Steady State Capacity**

**Expected Load Profile** ↔ **Steady State Power**

**Condensing Unit Rating (AWEF)**
AHRI 1250-2010 Section 5.1

**Apply Nominal Values for Saturated Suction, Evap. Fan Motor and Defrost Energy**

**Output AWEF Values Standardized**

Source: Department of Energy
### Table III.5—Calculations for Unit Cooler Saturated Suction Temperature and Energy Use Factors

<table>
<thead>
<tr>
<th>Medium temperature</th>
<th>Low temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated Suction Temperature (°F)</td>
<td>25 (0.013 \times Q)</td>
</tr>
<tr>
<td>On-cycle evaporator fan power (W)</td>
<td>(0.013 \times Q)</td>
</tr>
<tr>
<td>Off-cycle evaporator fan power (W)</td>
<td>(0.2 \times ) on-cycle evaporator fan power</td>
</tr>
<tr>
<td>Electric defrost energy per cycle (W-h/cycle)</td>
<td>0</td>
</tr>
<tr>
<td>Electric defrost heat contribution per cycle (Btu/cycle)</td>
<td>0</td>
</tr>
<tr>
<td>Hot gas defrost energy per cycle (W-h/cycle)</td>
<td>0</td>
</tr>
<tr>
<td>Hot gas defrost heat contribution per cycle (Btu)</td>
<td>0</td>
</tr>
<tr>
<td>Number of cycles per day</td>
<td>As specified in installation instructions or, if no instructions, 2.5</td>
</tr>
</tbody>
</table>

*Q represents the gross capacity at the highest ambient rating condition in Btu/h.

### Table 18. Unit Cooler Nominal Values for Condensing Unit Energy Calculations

<table>
<thead>
<tr>
<th>Description</th>
<th>Cooler</th>
<th>Freezer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated Suction Temperature, °F</td>
<td>25</td>
<td>-20</td>
</tr>
<tr>
<td>On-cycle evaporator fan power, per Btu/h of gross capacity at ambient condition, W-h/Btu</td>
<td>0.016</td>
<td>0.016</td>
</tr>
<tr>
<td>Off-cycle evaporator fan power, W</td>
<td>(0.2 \times ) on-cycle evaporator fan power</td>
<td></td>
</tr>
<tr>
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<td>Daily electric defrost contribution, Btu</td>
<td>(0.95 \times) daily defrost energy use (\times 3.413)</td>
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Source: Department of Energy & AHRI
## Minimum AWEF 2017

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<td>0.00023Q + 2.73</td>
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<td>Low Temp (&gt;2 HP)</td>
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Q is the unit capacity at -20 °F evap.

*Source: Department of Energy*
Indoor AWEF Example Calculations

1. **Low-Temperature Indoor R404A (Freezer)**
   - ¾ HP  \( Q = 3,330 \text{ Btu/H} \quad E = 875 \text{ W} \)
   - AWEF (indoor LT -20 °F evap) = \( 0.502Q / (0.605 E + 0.0309 Q) = 2.65 \)
   - Min AWEF = \( 0.0000593 Q + 2.33 = 2.53 \) “PASS”

2. **Medium-Temperature Indoor R134a (Cooler)**
   - 2 HP  \( Q = 9,990 \text{ Btu/H} \quad E = 1,425 \text{ W} \)
   - AWEF (indoor MT +25 °F evap) = \( 0.285 Q / (0.304 E + 0.0057 Q) = 5.81 \)
   - Min AWEF = 5.61 “PASS”

Source: Emerson Climate Technologies
Indoor AWEF Example
Condensing Unit Improvements

- **Small Indoor Medium Temp Cooler R134a**
  - ½ HP Q=5000 Btu/H E=900W (140W fan motor + 760W compressor)
  - AWEF (indoor MT +25F evap) = \( \frac{0.285Q}{0.304E + 0.0057Q} = 4.71 \)
  - Min AWEF = 5.61 “FAIL” – needs 19% improvement

- **Possible improvements: CSR compressor, larger condenser coil, improved airflow, ECM fan motor, alternative refrigerant.**
  - If condensing unit power can be reduced to 741W (from 900W) this unit will pass, assuming capacity holds at 5000 Btu/H.
  - Capacitor Start / Capacitor Run compressor model is available and would only draw 706W (not 760W)
  - ECM fan motor would draw less than 40W (not 140W).
  - Better condenser will reduce TD, and compressor will run more efficiently. TD=28.6F in this example.

- **Get TD down to 25F and CSR compressor will only draw 693W**
  - Now AWEF = 5.67 Pass!

Source: Emerson Climate Technologies
### Low-Temp Outdoor Calculation (6 HP)

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#### Net Capacity and System Wats

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#### Evap Fan Output

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Total: 116524691.5 19624252 99134187

Note: DOE minimum AWEF for this system is 4.79

1. **Low-Temp Outdoor R404A (Freezer)**
   1. 6 HP Q = 27,600 Btu/H
   2. AWEF (outdoor LT -20 °F evap) = 5.05
   3. Min AWEF = 4.79 “PASS”

Source: Emerson Climate Technologies
With AHRI 1250-2014 AWEF XLS Calculator
# Medium-Temp Outdoor Calc (2 HP)

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## Net Capacity and System Watts

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## Evap Fan Output

1. Medium-Temp Outdoor R404A (Cooler)
   1. 2 HP  \( Q = 17,400 \)
   2. AWEF (outdoor MT +25 °F evap) = 10.49
   3. Min AWEF = 7.60  “PASS”

Source: Emerson Climate Technologies

With AHRI 1250-2014 AWEF XLS Calculator

Note: DOE minimum AWEF for this MT system is 7.60
Floating Head Pressure vs. Fixed Ambient temperature variation during one day

Energy Saving Opportunity

Source: Emerson Climate Technologies
Taking Advantage of Low Ambient

- Condenser
- Compressor
- Evaporator
- EX Valve

60 °F Condensing During 50% of the Year

62% More Capacity
Double the Energy Efficiency Ratio

Floating Head System

Source: Emerson Climate Technologies
Outdoor AWEF Example
Condensing Unit Improvements

- 1.0 HP low-temp R404A outdoor freezer unit
  - Great compressor
  - Oversized coil
  - Floating head
  - ECM fan motor — all the bells and whistles!

- 2970 Btu/H, so minimum AWEF = 0.00023 (2970) + 2.73 = 3.42
- BIN analysis shows that this great unit only has AWEF of 3.06
- 12% improvement needed
- Any suggestions?

Source: Emerson Climate Technologies
Polling Question #3

Has our webinar been helpful to you today?

a. Very  
b. Somewhat  
c. Not very
Thank You!

What Questions Do You Have?

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