Laboratory Grade Refrigerators and Freezers Framework Discussion

ENERGY STAR® Labeled Products Program

September 22, 2010
Activities To Date

• Test method for lab grade developed in 2009
  – EPA and stakeholders developed a supplement to ASHRAE Standard 72-2005

• EPA issued call for data in December 2009
  – Three manufacturers tested products and submitted data to EPA

• Data Analysis and Framework Document released September 7, 2010
  – Stakeholder meeting on September 22 to discuss results and interpretations
Goals for Today’s Discussion

• Present analysis of test data received to date
• Discuss questions of interpretation raised by the data
• Discuss upcoming testing and verification changes to the ENERGY STAR program
• Request additional test data
  – Specification development process will not move forward without more data
Goals for Today’s Discussion (cont.)

• Discuss any other issues raised by the Data Analysis and Framework Document

• Comment period open until September 30, 2010.

Issues for comment will be highlighted in boxes such as this.

• Slides will be made available online after the webinar.
Product Definitions

• Laboratory Grade Refrigerator
  – A refrigerated cabinet used for storing non-volatile reagents and biological specimens at temperatures between 23 and 53.6 °F (-5 and 12 °C) . . .

• Laboratory Grade Freezer
  – A refrigerated cabinet used for storing volatile reagents and biological specimens at temperatures between -40 and 50 °F (-40 and 10 °C) . . .

• Combination Laboratory Grade Refrigerator/Freezer
  – A product composed of two or more refrigerated cabinets, one of which meets the definition of Laboratory Grade Refrigerator and another that meets the definition of Laboratory Grade Freezer.
Product Definitions (cont.)

- Equipment types not analyzed:
  - Portable Laboratory Refrigerator/Freezer
  - Explosion-Proof Refrigerator/Freezer
  - Ultra-Low Temperature Laboratory Freezer
  - Walk-in Laboratory Grade Refrigerator

EPA seeks comment on:
- Whether the definitions correctly describe the major distinctions between equipment types
Performance Metrics

• Per ASHRAE Standard 72-2005 with ENERGY STAR Lab Grade Supplement

• 24-hour Energy Consumption (kWh/day)
  – Includes door openings
    ▪ Refrigerators: for 15 seconds, every 20 minutes, over 8 hours
    ▪ Freezers: for 15 seconds, every hour, over 8 hours
  – Includes defrost cycles (if automatic/continuous)

• Temperature Uniformity
  – Two samples, 3 hours each: during defrost and steady state
  – Min., max., and standard deviation of temperature during tests
## Overview of Data Analyzed

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Nominal Temp.</th>
<th>Door Type</th>
<th>Defrost Strategy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freezer</td>
<td>-20°C (-4°F)</td>
<td>Solid</td>
<td>Automatic</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Manual</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continuous</td>
<td>1</td>
</tr>
<tr>
<td>Freezer</td>
<td>-30°C (-22°F)</td>
<td>Solid</td>
<td>Automatic</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Manual</td>
<td>1</td>
</tr>
<tr>
<td>Freezer Total</td>
<td></td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>+4°C (+39°F)</td>
<td>Glass</td>
<td>Automatic</td>
<td>5</td>
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<td></td>
<td></td>
<td></td>
<td>Manual</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continuous</td>
<td>2</td>
</tr>
<tr>
<td>Refrigerator</td>
<td></td>
<td>Solid</td>
<td>Automatic</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Manual</td>
<td>1</td>
</tr>
<tr>
<td>Refrigerator Total</td>
<td></td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Refrigerator /Freezer Combination</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>
EPA seeks comment on:

- Whether the range of volumes is representative of the majority of the laboratory grade market
Normalizing energy consumption by volume: Energy Intensity

- Refrigerators (+4 C)
- Refriger/Freezer Combination (+4 C/-20 C)
- Refriger/Freezer Combination (+4 C/-30 C)
- Freezer (-20 C)
- Freezer (-30 C)
Overview of Data Analyzed (cont.)

Energy Intensity versus Temperature

- Refrigerators (+4 C)
- Refriger/Freezer Combination (+4 C/-20 C)
- Refriger/Freezer Combination (+4 C/-30 C)
- Freezer (-20 C)
- Freezer (-30 C)
Impact of Product Characteristics on Performance

• Previous slides show some differentiation in performance between products

• EPA analyzed the impacts of three characteristics related to product utility:
  1. Door type:
     - glass or solid
     - only concerns refrigerators
  2. Defrosting strategy
  3. Intended application
Door Type (Refrigerator)

**Graphs:**

1. **Total Energy Input (kWh/dy):**
   - Green diamonds: Glass Door, Avg. St. Dev. $\leq 2.1^\circ F$
   - Red circles: Glass Door, Avg. St. Dev. $> 2.1^\circ F$
   - Green squares: Solid Door, Avg. St. Dev. $\leq 2.1^\circ F$
   - Red circles: Solid Door, Avg. St. Dev. $> 2.1^\circ F$

2. **Energy Intensity (kWh/dy/ft³):**
   - Green diamonds: Glass Door, Avg. St. Dev. $\leq 2.1^\circ F$
   - Red circles: Glass Door, Avg. St. Dev. $> 2.1^\circ F$
   - Green squares: Solid Door, Avg. St. Dev. $\leq 2.1^\circ F$
   - Red circles: Solid Door, Avg. St. Dev. $> 2.1^\circ F$
EPA seeks comment on:

- The representativeness of the above data
- Any design features that may explain the lesser impact of door type on performance in lab grade equipment
Defrost Strategy

- EPA received data on equipment with three defrost strategies:
  1. Manual
  2. Automatic
  3. Continuous
Defrost Strategy (cont.)

Impact of defrosting on temperature inside refrigeration cabinet:

- Full 24-Hour Test
- Defrost Cycle
- Steady State

Temperature vs. Time (hr:min)

Frequency vs. Temperature Bin (°F)
Defrost Strategy (cont.)

EPA seeks comment on:

- The apparent lack of temperature variation during the defrost cycle.
- Whether average standard deviation correctly represents uniformity.
Defrost Strategy (+4 °C Refrigerators)
Defrost Strategy
(+4 °C Refrigerators, cont.)

![Graph showing energy intensity vs. average standard deviation (°F)]

- Automatic Defrost
- Manual Defrost
- Continuous Defrost
Defrost Strategy
(-20 °C Freezers)

- Automatic Defrost, ≤ 4.3°F Avg. St. Dev.
- Continuous Defrost, ≤ 4.3°F Avg. St. Dev.
Defrost Strategy (-20 °C Freezers, cont.)

Energy Intensity (kWh/d/ft³) vs. Avg. St. Dev. (°F)
Defrost Strategy
(-30 °C Freezers)

- Energy intensity and total energy input plotted against measured interior volume.
- Green dots represent automatic defrost, ≤ 5.1°F with Avg. St. Dev.
- Red dots represent automatic defrost, > 5.1°F with Avg. St. Dev.
- Green triangles represent manual defrost, ≤ 5.1°F with Avg. St. Dev.
Defrost Strategy
(-30 °C Freezers, cont.)

The graph shows the energy intensity (kWh/day/ft³) plotted against the average standard deviation (°F) for automatic and manual defrost strategies. The graph indicates a higher energy intensity for automatic defrost as the average standard deviation increases compared to manual defrost.
Defrost Strategy Summary

- Potential relationship between defrost type and energy consumption/energy intensity for:
  - Refrigerators (+4 °C)
  - Freezers (-30 °C)

- Potential relationship between defrost type and stability
  - Freezers (-30 °C)

- Small sample size

EPA seeks comment on:
  - Whether the above relationships are true in general
EPA seeks comment on:

- Impacts of application-specific design options on performance
- Any other applications that should be evaluated
EPA analyzed the impacts of three characteristics:

1. **Door type**: no apparent impact on performance
2. **Defrosting strategy**: some impact on energy consumption and temperature stability
3. **Intended application**: some impact on energy consumption

EPA seeks comment on:
- The impacts of the above characteristics on performance
- Any other characteristics that should be considered
Based on data submitted to date, EPA is considering this scheme for classification of lab grade equipment:

- Energy consumption of combination units could be apportioned based on volume of each cabinet.

**Equipment Type** | **Defrost Strategy**
---|---
Refrigerators at +4° C (39° F) | Automatic
Freezers at -20° C (-4° F) | Automatic
Freezers at -30° C (-22° F) | Automatic

EPA seeks comment on:

- The classification framework under consideration.
Request for Additional Test Data

- Only three manufacturers submitted data to date
  - Additional results needed to move forward specification development process
- EPA seeks additional tests through Nov. 2010
  - Tests should be conducted on a variety of products in accordance with the ENERGY STAR lab grade supplement
Request for Additional Test Data (cont.)

• Temperature Uniformity
  – Previously collecting average of the standard deviations of each thermocouple
  – Would like to request temperature samples to investigate alternate methods of quantifying temperature uniformity.

EPA seeks comment on:
  – The relative importance of the magnitude versus duration of temperature deviations.
### Proposed Schedule

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments on Framework Document due to EPA</td>
<td>September 30, 2010</td>
</tr>
<tr>
<td>Additional product testing and data analysis</td>
<td>September–November 2010</td>
</tr>
<tr>
<td>EPA decision whether to develop specification</td>
<td>December 2010</td>
</tr>
<tr>
<td>Potential Draft 1 specification released for comment</td>
<td>January 2011 (Potential)</td>
</tr>
<tr>
<td>Potential stakeholder meeting to discuss Draft 1</td>
<td>February 2011 (Potential)</td>
</tr>
</tbody>
</table>
• For the past year, EPA has been working on enhancements to the testing and verification aspects of the ENERGY STAR program
  – Third-party certification of test results
  – Use of recognized laboratories
  – Annual submission of unit shipment data

• Additional info:
  www.energystar.gov/testingandverification
Contact Information

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• labgraderefrigeration@energystar.gov

• www.energystar.gov/newspecs