ENERGY STAR®
Uninterruptible Power Supplies:
Final Draft Test Method and
Specification Proposed Changes

Stakeholder Webinar
February 15, 2012

U.S. Department of Energy
U.S. Environmental Protection Agency

Webinar Details

• Webinar and related materials will be available on the UPS web page:
  – www.energystar.gov/newspecs
  – Follow link to “Uninterruptible Power Supplies”
• Audio provided via teleconference:
  Call in: +1 (877) 423-6338 (U.S.)
  +1 (571) 281-2578 (International)
  Code: 456-417
  – Phone lines will remain open during discussion
  – Please keep phone lines on mute unless speaking
  – Press *6 to mute or un-mute your line
  – Refer to the agenda for approximate discussion timing
### Agenda

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### Activities To Date

- Late 2010: Development of Draft Test Method
- January–March 2011: Data assembly conducted
- May 5, 2011: Draft 1 Specification
- July 15, 2011: Draft 2 Specification & Test Method
- Nov. & Dec. 2011: Draft 3 comment review

- **Today, Feb. 15th:** Discussion of proposed changes for the Final Draft specification & test method
Written Comments

- In addition to making verbal comments during the meeting, stakeholders may submit written comments.
- Please send all comments to: ups@energystar.gov

EPA and DOE will release the Final Draft specification and test method in early March followed by a 2-3 week comment period.

Webinar Objectives

1. Overview of proposed revisions for the Final Draft specification & test method
2. Final opportunity for group discussion on unresolved specification and test method issues
3. Discuss next steps for manufacturers, labs, and certification bodies (CBs)
Opening Comment

- Moving toward Final Draft
- Memo issued to discuss some remaining items
- Do not want to enter Final Draft with these items open, or unexamined by stakeholders
- Memo contains proposals
  - No fait accompli
  - We need to explain them, discuss them, and understand their impact

Proposed Changes to the Test Method

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Introduction

• Draft 3.0 Test Method published October 25, 2011
• Stakeholder comments received November 22, 2011
• Changes made to updated Draft Test Method based on stakeholder comments

Final Draft Changes Overview

1. Providing Testing Guidance
2. Energy Storage System Alarm Suppression
3. Steady state Check
4. Energy Accumulation Sampling Method
5. Efficiency and Average Power Calculations
6. Supplemental Information
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Stakeholder Comment #1: Testing Guidance

- Draft 3.0 Test Method
  - Guidance provided to test labs must be available in product user manuals
- Stakeholder Comment
  - Many UPSs require specific testing guidance
  - Recommend allowing manufacturer guidance on UPS models
  - Guidance made available in publicly available documents and referenced in reporting
Proposed Change #1: Testing Guidance

- Manufacturers may provide guidance on particular UPS models in publicly available documents
  - Example guidance – initial configurations, disconnecting the battery, disabling alarms
  - Guidance referenced in PPDS and documented in test reporting template\(^1\) (subject to change/revision)
- Will ensure lab-to-lab repeatability throughout qualification testing, off-the-shelf testing, etc.

\(^1\) The test reporting template is to be completed by laboratory.

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Stakeholder Comment #2: Energy Storage System

- Draft 3.0 Test Method
  - UPS tested in as-shipped condition
  - UPS tested with energy storage system disconnected only if allowed by user manual
- Stakeholder Comments
  - Testing the UPS with the battery connected overly burdensome
  - Recommend allowing configuration changes, as long as controls to do so are natively present on UPS

Proposed Change #2: Energy Storage System

- Allow necessary actions to suppress alarms, indications, and fault detection mechanisms that result from removing the energy storage system
- Controls necessary to do so natively present on UPS
- Will ensure repeatable testing throughout qualification testing, off-the-shelf testing, etc.
Final Draft Changes Overview

- Providing Testing Guidance
- Energy Storage System Alarm Suppression
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- Supplemental Information

Stakeholder Comment #3: Steady-state Check

- Draft 3.0 Test Method
  - Performed after IEC 62040-3, Ed. 2.0 stabilization period (125% temperature rise time)
  - Compare two 5-minute average power calculations
- Stakeholder Comments
  - Proposed method increases test burden, has not been tested on large UPSs
  - Recommend using only the thermal stability requirement detailed in IEC 62040-3, Ed. 2.0
Proposed Change #3: Steady-state Check

• Perform stability check in final 20 minutes of the stabilization period (125% of temperature rise time)
  – Minimizes additional test time

Proposed Change #3: Steady-state Check

• Evaluate efficiency instead of average power
  – Power may drift, but efficiency stays constant
  – Reduces steady-state requirements, regardless of UPS size
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Stakeholder Comment #4: Accumulated Energy Sampling Method

- Draft 3.0 Test Method
  - Determine average power from 15-minute accumulated energy measurement
- Stakeholder Comments
  - Not defined in detail
  - Has not been widely used
  - Adds test burden
Proposed Change #4: Accumulated Energy Sampling Method

- Accumulation sampling method:
  - Suppresses effects of outlier data
  - Taken over duration of test and displayed on power meter
    - 1 measurement instead of the 3 required in IEC 62040-3, Ed. 2.0
  - Avoids the need for data acquisition programs

Proposed Change #4: Accumulated Energy Sampling Method

- Outlier data example

  ![Graph showing instantaneaus input power at 100% load]
Proposed Change #4: Accumulated Energy Sampling Method

- Clarification made to add definition to sampling method
  - The rate at which the power meter calculates the accumulated energy (Wh) shall be at least 1 Hz

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Proposed Change #5: Efficiency and Average Power Calculations

- Equations for the average power and efficiency calculations have been added:
  - \( P_{AVG} = \frac{\text{Total Energy (Wh)}}{\text{Duration of Test (hours)}} \)
  - Efficiency = \( \frac{P_{AVG,\text{OUT}}}{P_{AVG,\text{IN}}} \)

Final Draft Changes Overview

<p>| | |</p>
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Supplemental Information

- The following have been added to the test reporting template:
  - Battery part numbers, quantities, and connection status
    - Ensures the manufacturer-specified battery is tested
  - Section for documenting any unit-specific configuration steps taken
  - Firmware revision and configuration number

Summary of Proposed Changes

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<th>Final Draft Test Method</th>
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<td>Guidance must be provided in user manual</td>
<td>Testing guidance must be provided in publicly available documents, referenced in the PPDS, and documented by the lab</td>
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<tr>
<td>Energy Storage System</td>
<td>UPS tested in as-shipped configuration in accordance with user manual</td>
<td>Changes to as-shipped configuration are allowed as long as the controls are natively present on UPS and test guidance reporting guidelines (above) are followed</td>
</tr>
</tbody>
</table>
| Stability Check      | • Performed after stabilization period                                                | • Performed in the final 20 minutes of stabilization period
  • Two average power calculations compared | • Two efficiency calculations compared                                                                                                                   |
| Energy Accumulation Method | Not specified                                                                        | Accumulation rate of 1 Hz or greater                                                                                                                                                                                  |
| Efficiency and Average Power | Not specified                                                                        | Equations for average power and efficiency added                                                                                                       |
Rotary UPS

- Following Draft 3, EPA & DOE received comments concerning the applicability of the test method & specification to Rotary UPS
- Based on comments received, EPA has found:
  - No prohibitive differences between Rotary UPS test procedures per IEC 88528-11 and the ES test method
  - Procedures are more precisely specified in IEC 62040-3 & ES Test Method than in the IEC 88528-11
- Rotary UPS stakeholder commented that IEC 62040-3 is easily applicable and was previously used for Rotary UPSs prior to IEC 88528-11
Rotary UPS

- Technology neutrality similar to the energy storage system (flywheels, batteries, etc. permitted)
- Provides consumers with a wide variety of efficient products for comparison
  - Only the most efficient Rotary UPSs will likely meet specification requirements
  - For some purchasers, Rotary UPSs offer system-wide savings benefits
- EPA and DOE propose to maintain Rotary UPS within the scope with a few modifications

Rotary UPS Definitions

- Include definitions for the two major Rotary UPS designs:
  1. Rotary UPS (RUPS) without Diesel
  2. Diesel-coupled rotary UPS (DRUPS)
- Clarify condition for Stored Energy Mode:
  - “All power is derived from the energy storage system or, in case of a DRUPS, from the integrated Diesel engine or a combination of both.”
Test Method: Rotary UPS Request for Comment

- DOE and EPA would like to ensure a repeatable and technology neutral test method
- The language of the updated Draft Test Method has been modified to be technology neutral
- DOE and EPA welcome all comments on Rotary UPSs, particularly:
  - What changes, if any, could be made to make the test method language more technology neutral?
  - Do all measurement methods adequately address Rotary UPSs?

Bypass Clarification

**Bypass**: Power path alternative to the ac converter.
- **Maintenance Bypass (path)**: Alternative power path provided to maintain continuity of load power during maintenance activities.
- **Automatic bypass**: Power path (primary or stand-by) alternative to the indirect ac converter capable of control without human intervention, in response to the occurrence of predetermined conditions
  - **Mechanical Bypass**: Control is via a switch with mechanically separable contacts.
  - **Static Bypass (electronic bypass)**: Control is via an electronic power switch, for example transistors, thyristors, triacs or other semiconductor device or devices.
  - **Hybrid Bypass**: Control is via switch with mechanically separable contacts in combination with at least one controlled electronic valve device.

Per IEC 665-29, allow for manual, automatic, or combination of both
Power Factor

• Per stakeholder comments, include definition:

  **Power Factor**: ratio of the absolute value of active power $P$ to the apparent power $S$

• VFD: Load is connected directly to the source, such that UPS does not impact power factor
• Power factor still obtained for all modes in Test Method

• EPA proposes that only VFI and VI modes meet the power factor minimum requirement of **0.90**

Reference Test Load: Injection Into the AC Supply

• In Draft 1 & 2, EPA aligned with IEC backfeeding provisions

  **IEC 62040-3**: Reference Test Load: Load or condition in which the output of the UPS delivers the active power (W) for which the UPS is rated.*

  *Footnote: “This definition permits when in test-mode and subject to local regulations, the UPS output to be injected into the input a.c. supply”

• **Draft 1 & 2 ENERGY STAR speciation**: “This definition permits the UPS output to be backfed into the input AC supply when in test-mode and subject to local regulations.”
Reference Test Load:
Backfeeding

- In Draft 3, EPA removed the backfeeding allowance based on stakeholder comment that there is lower repeatability compared to a dedicated test load.
- Further stakeholder comments indicated that prohibiting backfeeding is a potential burden, requiring test houses to purchase large, dedicated test loads.
- EPA proposes to revert back to IEC 62040-3 and allow backfeeding/injecting into the ac supply during test for UPS systems > 100 kW.

Revised Efficiency Levels

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Overview

- EPA received several stakeholder suggestions for
  - Modified efficiency levels
  - Modified loading profiles
- Each stakeholder proposal was examined against the existing dataset
- EPA also re-examined its levels in light of stakeholder suggestions
  - This resulted in a loading profile change
  - Loading profile change resulted in two level changes to maintain estimated market share

Draft 3 Ac-output Efficiency Requirements

- Efficiency Requirement:

<table>
<thead>
<tr>
<th>Output Power</th>
<th>VFD</th>
<th>VI</th>
<th>VFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P ≤ 1000 W</td>
<td>0.97</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>1500 W &lt; P ≤ 10,000 W</td>
<td>0.97</td>
<td>0.96</td>
<td>0.0099 × ln(P) + 0.805</td>
</tr>
<tr>
<td>P &gt; 10,000 W</td>
<td>0.97</td>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

- Loading Profile:

<table>
<thead>
<tr>
<th>Output Power, P, in kilowatts (kW)</th>
<th>Proportion of Time Spent at Specified Proportion of Reference Test Load, t_{%}</th>
</tr>
</thead>
<tbody>
<tr>
<td>P ≤ 1.5 kW</td>
<td>25% 50% 75% 100%</td>
</tr>
<tr>
<td>1.5 kW &lt; P ≤ 10 kW</td>
<td>0.2 0.2 0.3 0.3</td>
</tr>
<tr>
<td>P &gt; 10 kW</td>
<td>0.25 0.50 0.25 0.0</td>
</tr>
</tbody>
</table>

- 2% Metering Incentive for UPSs > 10 kW
Proposed Loading Profile Adjustment

- EPA received a stakeholder proposal to alter the loading profile for commercially-oriented products in the <1.5kW range.
  - EPA re-examined data set in light of proposal
  - Examined market data
- EPA proposes to adopt this new loading profile

Proposed Level Adjustments

- In conjunction with load profile change.
- Tightening up
  - VFI: +1%
  - VI (1.5 – 10kW): +1%
Proposed Adjustments

• Three areas of concern:
  – Projected VFI qualification rates
  – VI qualification, 1.5 – 10kW
  – VFD qualification rates, <1.5kW

VFI Qualification Rates

• With Draft 3 levels:
  – <1.5kW and >10kW market shares are balanced
     • Highlight efficiency while allowing range of products on the market.
  – But the 1.5 – 10kW range has high market share
• Applied new loading profile (<1.5kW VFI)
  – Effect: Raises reported efficiency of <1.5kW range
  – Raises market share of this range to high level
  – New loading profile restored some balance to the line—"higher" balance in the 0 – 10kW range.
• EPA proposes increasing VFI level (+1%) to bring total VFI market share back into balance
• Total market share of VFI given new loading profile:
  – Old level: 50%
  – New level: 30%
VI Qualification Rates

- Proposed: Change 1.5 – 10kW
  - Level moves from 96% → 97%
- Overall Draft 3 market share of VI was on target
  - Some under/overshoot between <1.5kW and 1.5 – 10kW ranges
- New loading profile for <1.5kW
  - Now on-target/overshoot
  - Raises our overall market share
- Proposed levels are a correction to make this on-target across full range of UPS output power.

VFD Qualification Rates

- VFD:
  - Data in the <1.5kW range is quite tight
  - Small changes to levels result in large swings in market penetration
    - Ex.: 97.5% → 97.0%
      - From raw data, 10% → 48% market share from a 0.5% level change.
  - Difficult to predict market share based on any level.
    - Heavily dependent on assumptions about:
      - Unit-to-unit variation, test repeatability, accuracy of data.
Overall Market Share

<table>
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<tr>
<th>VFD</th>
<th>VI</th>
<th>VFI</th>
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<tr>
<td>25% (17 – 54%)</td>
<td>27%</td>
<td>30%</td>
</tr>
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</table>

- With new loading profile, plus level changes
- VFD level difficult to forecast due to data clustering
  - Very likely to be closer to mid-20s

Proposed Changes to Efficiency Requirements

- To maintain the value of the ENERGY STAR mark as a differentiator, EPA proposes to revise the efficiency requirements in Final Draft

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<th>Higher efficiency requirements for:</th>
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<td>VFI: +1%</td>
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<tr>
<td></td>
<td>VI (1.5 kW &lt; P ≤ 10 kW): +1%</td>
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<tr>
<th>Loading</th>
<th>Promote a wide range of qualifying VI and VFI UPSs ≤ 1.5 kW by:</th>
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<td>Applying stakeholder-proposed (commercial) loading profiles</td>
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<tr>
<th>Metering Incentive</th>
<th>Reduce metering incentive for UPSs &gt; 10 kW (datacenters) to 1%</th>
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</thead>
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Proposed Changes to Efficiency Requirements

- Efficiency Levels:

- Loading Profiles:

- Efficiency Levels with Metering Incentive:

Multiple-normal-mode UPS

- EPA proposes to modify the requirement that “Multiple-normal-mode UPS systems shall ship with their highest-input dependency mode enabled by default”
Multiple-normal-mode UPS

• Per stakeholder comments, EPA proposes to include the following clarification:
  – **ALL supported normal modes shall still be tested and reported** on the PPDS regardless of whether the Multiple-normal-mode average efficiency calculation is applied in the model’s qualification
  
  -however-
  
  – UPSs meeting efficiency requirements in their lowest input dependency mode (i.e., without benefit from the weighted equation) **shall not be required to ship in the highest input dependency mode**

Multiple-normal-mode UPS Reporting Requirements

• In Draft 3, EPA proposed that the **longest transfer time** between normal modes be reported on the PPDS
  – Transfer time is not measured by the ENERGY STAR UPS Test Method
  – One stakeholder commented that only data relevant to efficiency should be reported on the PPDS
  – Consumers may refer to the vendor website via PPDS link

• In considering these points, EPA proposes to remove transfer time from reporting requirements and the PPDS
Metering Incentive & Requirements

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Metering: Goals

- Support measurement of data center Power Usage Effectiveness (PUE) = \( \frac{\text{Data center energy}}{\text{IT energy}} \)
  - Promote consistent measurement
  - Promote ease of measurement

(Source: The Green Grid)
**Metering: Draft 3 Proposal**

- In Draft 3, EPA proposed an efficiency incentive for UPSs with a meter possessing the following characteristics:
  - Meter either installed internally or shipped as an independent, external component bundled with the UPS system at the point-of-sale
  - The meter must at a minimum measure kWh
- EPA asked stakeholders to comment on the incentive proposal, with specific attention paid to accuracy, communications, display, and reporting requirements

**Metering: Scope**

- Remote monitoring and measurement is already commonplace in Dc-output UPS environments
- Telecommunications industry does not fall under the ENERGY STAR Buildings Program
- Dc energy measurement accuracy standards are not widely available
- EPA proposes that the metering incentive only apply to Ac-output UPSs > 10 kW
**Metering: Accuracy**

- Stakeholders proposed a 5% energy measurement accuracy level
  - EPA is concerned that resulting measurement errors may be too great for meaningful PUE calculations
  - EPA is unaware of any standard reference that determines an energy measurement accuracy of 5%

- EPA proposes that internal and bundled external meters meet Class 2 accuracy requirements per IEC 62053-21

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**Metering: Accuracy**

- EPA believes included meters should have an accuracy comparable to those available on the market

*Meters available on the market with Class 1 and Class 0.5s accuracy in the $200-400 range*
Metering: Communication Protocols

• Stakeholders agreed that the meter should communicate via a common protocol

• EPA proposes that the UPS and/or bundled external meter communicate measurement information via at least one of the following protocols:
  
  Modbus RTU, Modbus TCP, or SNMP (v1, 2, or 3)

Metering: Display

• EPA is not aware of any standardized display parameters or requirements applicable to a range of UPS and metering products
  
  • One stakeholder suggested EPA forgo a display requirement in the interest of limiting cost and encouraging greater adoption of meters

• EPA proposes that physical displays are not required for the incentive, provided that the UPS or external meter is capable of transmitting information to a software based interface
Metering: PPDS

• EPA proposes that the following metering characteristics be reported on the PPDS for each qualified model:

<table>
<thead>
<tr>
<th>Internal Output Energy Meter</th>
<th>(Yes/No)</th>
</tr>
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<tbody>
<tr>
<td>IEC 62053 Accuracy Class</td>
<td>Class 1,2,0.2s,0.5s, N/A</td>
</tr>
<tr>
<td>Physical Display</td>
<td>(Yes/No)</td>
</tr>
<tr>
<td>Data Provided via Network Communication</td>
<td>(Yes/No)</td>
</tr>
<tr>
<td>Network Protocols</td>
<td>Modbus RTU, Modbus TCP, SNMP (v1,2,or3), Other</td>
</tr>
<tr>
<td>Data Available via Web Browser</td>
<td>(Yes/No)</td>
</tr>
</tbody>
</table>

| External Meter Manufacturer   | |
| External Meter Model Number   | |

Qualification Processes

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<td>11:50 – 12:00</td>
<td>Open Items &amp; Questions</td>
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</tbody>
</table>
Modular Ac-output UPS

- In Draft 3, EPA proposed that manufacturers shall test at the min and max capabilities of the chassis
  - Stakeholders commented that the minimum configuration may not actually be available for sale on the market
  - More valuable to test configurations that consumers will actually use

- Thus, EPA proposes that manufacturers may determine the minimum configuration as it is unlikely that the model will be used in a configuration with less modules than those installed at purchase

Modular UPS

- EPA also proposes that manufacturers specify the maximum configuration
  - EPA is concerned that testing the **chassis maximum** would mandate testing a configuration that may not pass
  - All intermediate configurations are then expected to meet the requirement
Modular UPS

- Where intermediate models within the Modular UPS Product Family do not meet efficiency requirements, each unique output power configuration may be tested and qualified individually.
  - Modular UPS provisions are intended to decrease qualification burden, but EPA acknowledges that it may not be practicable in all cases.

Power and Performance Datasheet (PPDS)

- Stakeholders had the following comments on the PPDS:
  - Develop and test a prototype to ensure PPDS is helpful and easy to use.
  - Prioritize the following characteristics:
    - topology,
    - input dependency,
    - input and output voltage,
    - modularity,
    - runtime at several load conditions, and
    - number of outlets (for UPSs ≤ 1500 W)
  - Also include test information and communication abilities.
  - Do not include mode transition time in the PPDS.
    - Outside of scope.
Power and Performance Datasheet (PPDS) (cont.)

- EPA will include stakeholder feedback in the development of the PPDS:
  - Publication of prototype PPDS following finalization of Specification
  - Opportunity for written and verbal feedback to ensure usefulness
  - Completion and testing of PPDS before Specification effective date to ensure ease of use

Specification Effective Date

- Effective date allows for a 3-month period for EPA to recognized certification bodies and laboratories

<table>
<thead>
<tr>
<th>Proposed Specification Effective Date</th>
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<tbody>
<tr>
<td>Late June 2012</td>
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Timeline

<table>
<thead>
<tr>
<th>Comments Due on Proposed Changes to Final Draft</th>
<th>February 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Draft Released</td>
<td>Early March</td>
</tr>
<tr>
<td>• Along with Data Fields for Qualification</td>
<td></td>
</tr>
<tr>
<td>Final Draft Comments Due</td>
<td>Late March</td>
</tr>
<tr>
<td>Final Specification Released</td>
<td>Late March</td>
</tr>
<tr>
<td>• Along with Manufacturer Partnership Agreements</td>
<td></td>
</tr>
<tr>
<td>Preparation for Program Start</td>
<td>April—May</td>
</tr>
<tr>
<td>• CB trainings</td>
<td></td>
</tr>
<tr>
<td>• Lab accreditation</td>
<td></td>
</tr>
<tr>
<td>Specification becomes effective</td>
<td>Late June</td>
</tr>
<tr>
<td>• First products posted on Qualified Products List online</td>
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</tbody>
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Next Steps

<table>
<thead>
<tr>
<th>Time (EST)</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>9:30 – 9:40</td>
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<tr>
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Written Comments

• Please send all comments to: ups@energystar.gov

Comment Deadline

February 24, 2011

• EPA and DOE will release the Final Draft specification and test method in early March following by a 2-3 week comment period

Manufacturer Resources

• Once the final Version 1.0 specification is published, manufacturers may submit a Partnership Agreement

• For resources and information, please visit: http://www.energystar.gov/index.cfm?c=manuf_res.pt_manuf

• If you have any questions, please email ups@energystar.gov
Open Items & Questions

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Open Items and Questions

- The line is now open for any items or questions that have not been addressed previously.
Thank you!

RJ Meyers  
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