Final Draft ENERGY STAR Supplement to ANSI/ASHRAE Standard 72-2005
For Laboratory Grade Refrigerators and Freezers
September 15, 2009

The U.S. Environmental Protection Agency (EPA) discussed the ANSI/ASHRAE Standard 72-2005, *Method of Testing Commercial Refrigerators and Freezers*, with several stakeholders to determine its applicability to laboratory applications. Preliminary feedback indicated that overall the test procedure is sound but revisions would need to be made to several test conditions to better represent laboratory grade applications and end user interests. The purpose of this supplement is to document the proposed changes to the test method presented in the standard in order to provide manufacturers with a meaningful and consistent method for measuring and comparing product energy efficiency and performance.

In August, 2009 a Draft 2 supplement to ANSI/ASHRAE Standard 72 was shared with stakeholders for review and comment. EPA followed up the draft proposal with a conference call to discuss initial stakeholder feedback. This Final Draft version incorporates several of the written comments and suggestions submitted to EPA as well as feedback provided during the stakeholder meeting.

Please note that this is the last opportunity to provide input before the supplement is finalized and manufacturers are asked to begin testing. Interested parties can submit comments to LabGradeRefrigeration@energystar.gov (note new mailbox) **by October 6, 2009**.

The purpose of the table below is to document the proposed supplemental changes to the test method presented in ANSI/ASHRAE Standard 72-2005. EPA does not have the authority to revise the standard and therefore, sections that might not be applicable to certain laboratory grade refrigerators and freezers should simply be deemed not applicable. In this supplement, EPA has only included those sections where additional guidance specific to laboratory grade refrigerators and freezers is proposed.

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ANSI/ASHRAE 72-2005 Reference	Current Requirement	Supplement for Lab Grade
Section 6: Apparatus		
Section 6.2 Loading of Test Simulators and Filler Packages – 6.2.1 Test Simulators	Section 6.2.1 provides the guidelines for the test simulator. The simulator shall be a plastic container (such as polyethylene) of at least 473 mL (1 US liquid pint) volume, with a lid conforming to the dimensions shown in Figure 3 of the test standard. The container shall be filled with any natural or artificial sponge material that is saturated with a heat transfer solution consisting of a 50/50 +/- 2% mixture (by volume) of propylene glycol and distilled water. The temperature shall be measured within the simulator at the volumetric center point.	Chamber should be empty during testing. Un-weighted, bare thermocouples should be used to measure temperature. **Note:** Most stakeholders agree that testing the chamber empty provides for a consistent manner in which to compare products, even if it is not exactly representative of real world operation, which also varies significantly. EPA is interested in choosing a mass that best represents lab grade products but this will take time and further discussion. Therefore, for purposes of comparison units will be tested empty.

Section 6.2: Loading of Test Simulators and Filler Packages – 6.2.2 Test Simulator Locations (Refrigerators with Shelves)	For each row of shelves in the refrigerated zone, there shall be two test simulators placed at each of the following locations: at the left end, at the right end, and at each shelf standard break between adjacent shelves. At each location, one test simulator shall be placed on the shelf surface at the front of the shelf and the other test simulator placed on the shelf surface at the rear edge of the shelf. For the bottom compartment display or storage area, there shall be two test simulators located at the left end, at the right end, and at the shelf standard break between adjacent shelves. At each location, both test simulators shall be placed to be in contact with the specified upper load-limit boundary, with one at the front and one at the back of the compartment.	Representative shelving should be used during testing. Representative shelving is defined as that which is installed as sold to the end user. If tested unit offers more than 1 type of shelf or shelf configuration, manufacturer must test and report each option separately. If unit also offers drawers then that configuration must also be tested separately. **Note:** The test results should represent the equipment as sold to the end user. Subtle differences in shelving and drawers could significantly affect air flow and as a result, energy consumption and uniformity. As such, manufacturers must test and record performance results for each individual configuration. Thermocouples should be placed on three planes located 1 inch above each shelf. Shelves should be placed in the: (1) top allowable position, (2) geometric center, and (3) lowest allowable position. Thermocouples should be placed in the geometric center and 3 inches from each corner of the shelf (5 sensors/shelf). **Note:** Several stakeholders provided suggestions regarding thermocouple placement. EPA decided that it is important that these locations represent useable space (i.e., where lab samples will be stored in the unit). Stakeholders are encouraged to provide feedback on this proposal.

Section 6.2: Loading of Test Simulators and Filler Packages – 6.2.3 Simulator Locations (Refrigerators without Shelves)	Test simulators shall be located at the left end, at the right end, and at 915 to 1220 mm (36 to 48 in.) intervals across the width of the refrigerator. At each location, test simulators shall be placed in the front and the rear, and at the top and bottom, in contact with the manufacturer's specified load-limit boundaries.	If a unit is sold without shelving then the manufacturer may test it without shelves. If the unit is sold without shelves but then offers different shelf types for installation in the field, then manufacturer should test each of those options. **Note:** EPA understands that it is rare that a laboratory grade refrigerator or freezer is sold without shelves. However, in the case where a unit's shelves or drawers are sold separately, as explained in Section 6.2.2 above, the manufacturer must ensure that all possible configurations are tested.
Section 6.2.4 – 6.2.5: Typical Locations and Filler Packages	Section 6.2.4 references figures within the test standard regarding typical multi-deck and single-deck refrigerators showing filler packaging and test simulator locations. Section 6.2.5 provides guidance regarding filler packages used as product mass.	NA – filler packages are not needed because test chamber is tested empty.
Section 7: Test Procedure		
Section 7.2: Door-Opening Requirements	Each door shall be in the fully open position for six seconds, six times per hour for eight consecutive hours. Each door shall be opened sequentially, one at a time. The eight-hour period of door openings shall begin three hours after the start of a defrost period. For units with pass-through doors, only the doors on one side of the unit shall be opened during the test. **For Hinged Doors:** Opened at an angle not less than 75°. **For Sliding Doors:** Opened as far as they will go. **Note:** Language from the ANSI/ ASHRAE 72 test method regarding the testing of hinged and sliding doors is reiterated in this supplement, above.	For Refrigerators: Each door shall be opened **for fifteen seconds, three times per hour,** for eight consecutive hours. For Freezers: Each door shall be opened **for fifteen seconds, once per hour** for eight consecutive hours. Each door shall be opened using even time intervals. **Note:** The time period for opening the freezer door during testing was changed from 30 seconds to 15 seconds to be consistent with the refrigerator requirement.

Section 7.3: Defrost	The test shall begin with a defrost period as shown in Figure 6 of the test standard. Test period is 24 hours.	**Manual:** 24-hour test period with no defrost cycle. **Automatic Timed:** Test period must be at least 24 hours with a minimum of 2 defrost cycles. **Automatic Smart or On Demand:** Test period must be at least 24 hours with a minimum of 1 defrost cycle (including pull down). If test period extends beyond 24 hrs to capture a defrost cycle manufacturer should derive kWh/day by dividing total hour duration by 24. **Note:** During the August Draft 2 stakeholder meeting this issue received significant discussion. If possible, EPA would like to cover as many product types as possible with this supplement within the general purpose and -20/-30 sub categories, both manual and automatic defrost. Several stakeholders agree that different defrost technologies require different testing parameters. The proposal above takes this concern into consideration. While smart defrost units are the most challenging to test in terms of capturing a defrost cycle, they do represent more energy-efficient designs and should be included in this effort. As such, EPA is proposing to require only one defrost cycle when testing these product types. Stakeholders are encouraged to provide feedback on this proposal.

Section 7.7: Test Simulator Temperature Measurement	After steady state conditions, the ambient, the test simulator temperatures, and all other data shall be recorded at **three-minute intervals** beginning at the start of the defrost period, through the defrost period, and through the running cycle until the beginning of the next successive defrost period. After this test period, all test simulators shall continue to be recorded throughout the 24-hour refrigerant flow period to ensure that no changes occur that would change the test results.	Testing for laboratory grade refrigerators and freezer will be recorded using the same approach as ANSI/ASHRAE 72.

Temperature Uniformity Test

- Measurements taken during energy consumption test over a 3-hour period while door is closed at 3-minute intervals.
  - Manufacturer must collect uniformity data during two 3-hour periods: one that includes a defrost cycle and one in steady state (i.e., no defrost cycle) **OR**
  - Manufacturer must report stability for the central thermocouple on each shelf (average temperature and +/- range).

Reporting Method

Manufacturers should report both the standard deviation and minimum/maximum temperatures collected during the test period:

Standard Deviation – Manufacturers use the standard deviation formula below and multiply the result by 3 to get 3 standard deviations of the average of all interval standard deviations. Where:

N = number of data points
X = average of all data points
Xi = data for individual data point at any particular time

$$s_N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

- **Min/Max Temperature –** Manufacturers report the minimum and maximum temperature during test period.

Note: The issue of whether or not to include a defrost cycle for purposes of measuring and reporting temperature uniformity generated a significant amount of discussion during the August meeting. Based on discussions with manufacturers, EPA understands that *uniformity* represents the capability of maintaining a set temperature within a given space and *stability* represents the capability of maintaining a set temperature over time. While defrost is expected to affect stability it should not significantly impact uniformity. However, EPA also understands end user concern that product integrity be protected even through defrost cycles. Therefore, EPA is proposing two options: (1) a second uniformity test that includes a defrost cycle or (2) the reporting of stability for the central thermocouple. Stakeholders are encouraged to provide feedback on these proposals.

Stakeholders agreed that both the standard deviation method and the min/max temperature reporting method were valuable but end users believed that the latter is the more simple and easy to understand approach. Since both reporting approaches utilize the same raw data points, EPA decided that manufacturers should report using both, thus providing the end user an opportunity to use the result that best supports their decision making process.

Additional Conditions

- All manually controlled accessories that come standard with the equipment must be installed and turned to the "ON" position during testing.
- Test procedure applicable to manual, automatic-timed, and smart or on demand defrost systems. Combination freezer-refrigerators are excluded at this time.

Note: A few stakeholders provided suggestions on testing combination freezer and refrigerator models. It was also noted that these units currently represent a small, but growing, market share. There are some challenges to testing and reporting results for this product type including how to evaluate systems that share a compressor system. EPA is interested in working with manufacturers to determine an appropriate approach for addressing this product type longer term. For this initial effort, combination units will be excluded to avoid further delays, with the intention of revisiting at a later date.

Several stakeholders suggested a requirement that units tested under this supplement meet certain safety certification requirements. Suggestions included: UL, CSA, and EN 61010 certifications. EPA is interested in requiring such certification in a potential ENERGY STAR specification to better define the product types covered by this supplement and to ensure that relevant safety standards are met.

Set-Point Temperature Requirements

Product Type	**Set-Point Temperature**	**Average of All Thermocouples During Entire Test Period**
General Purpose Laboratory Refrigerators	4 degrees C	4 degrees $\pm$ 1 degree C
Blood Bank Refrigerators	4 degrees C	4 degrees $\pm$ 1 degree C
Pharmacy and Chromatography Refrigerators	4 degrees C	4 degrees $\pm$ 1 degree C
General Purpose Laboratory Freezers	-20 degrees C	-20 degrees $\pm$ 1 degree C
-30 Freezers	-30 degrees C	-30 degrees $\pm$ 1 degree C
-20 Freezers	-20 degrees C	-20 degrees $\pm$ 1 degree C

Note: During the August meeting, there was some confusion regarding the definition of Integrated Average Temperature (IAT). The purpose of IAT is to determine the average temperature range of all thermocouples during the entire test period (i.e., all data points compiled, added, and averaged). Based on manufacturer discussions, EPA learned that IAT was originally included in the ANSI/ASHRAE 72 test method because of several instances where some units were reaching temperatures above allowable temperature required by NSF during the defrost cycle. Under the IAT requirement, units that are able to tightly or even moderately hold temperature and offer quick recovery times should be able to meet a +/- 1 degree C requirement. The IAT will eliminate poorly designed units that may perform well in regards to energy efficiency but also allow the temperatures to go above acceptable levels. EPA believes based on stakeholder discussions that this issue is also important to the laboratory community. Therefore, EPA is keeping this requirement in the supplement but renaming the metric to avoid further confusion. Furthermore, set point temperatures are provided for each product type based on application.

Proposed Testing/Specification Development Timeline

- Final Draft Supplement Released — September 15
- Comments on Final Draft Due to EPA — October 6
- Final Supplement Released — October 23
- Manufacturers Test and Report Results — October 23 – February 19
- Draft 1 Specification Released for Comment — March 11
- Stakeholder Meeting to Discuss Draft 1 — Late March
- Draft 1 Comments Due to EPA — Early April
- Draft 2 Specification Released for Comment — April/May
- Draft 2 Comments Due to EPA — Late May*

**Subsequent draft versions will be released, as needed, prior to finalization. Once final, the specification will become effective immediately.*

Reminder: As of January 1, 2010, laboratory grade refrigerators and freezers will no longer be eligible for ENERGY STAR qualification unless new requirements can be developed. Units qualified under the ENERGY STAR Version 1.0 Commercial Solid Door Refrigerator and Freezer specification will be removed from the ENERGY STAR qualified product list on January 1, 2010.

Note: The development of an ENERGY STAR specification for laboratory grade refrigerators and freezers is dependent on: a robust data set that presents significant differentiation among models and manufacturers; significant energy and carbon savings potential; and whether ENERGY STAR qualification is cost effective to the end user.