**EPA and DOE Responses to Stakeholder Comments**
**ENERGY STAR Laboratory Grade Refrigerator and Freezer Draft 1 Test Method**

| No. | Topic | Subtopic | Comment | DOE Response |
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| 1 | Certification | | Multiple samples should be used to calculate the average energy usage for the product. Typically with household products, a minimum sample size of 4 units is required for certification. | EPA will address certification in the ENERGY STAR specification. |
| 2 | Certification | | What is the typical sample size of a specific unit that needs to be tested? Is one unit sufficient or do you need to test multiple units of the same configuration? | |
| 3 | Certification | | Can manufactures perform their own testing or does EPA require a third party(certification body) to do the testing? I have noticed UL advertising Energy Star® testing as a service and we are wondering can we test to the standard ourselves? If we use an outside lab is the EPA certifying the outside labs? Is there a list of approved third party labs? Are we responsible for annual testing or what are the criteria for retesting? If a change is made to improve the unit what size of change will constitute retesting and resubmittal. A possible answer to this is as long as the energy usage doesn't change by some percentage no resubmittal is required. | |
| 4 | Certification | | The document does not list energy standards for ENERGY STAR certification. If the purpose of the E-Star certification is to help educate or properly inform users/potential buyers of these refrigeration products then the procedure should reflect the typical conditions that a user will see when using the product. However, to do this, specifications on the purpose of each type of unit (storage intent, set point, environment, door type etc.) may need to be addressed and/or subdivided. This will provide the user an understanding of the differences between the product options/designs and the impact these designs have on the performance/energy metrics important to the user. | |
| 5 | Definitions | Additional definitions | "Uniformity" and "Stability" should be defined. | DOE agrees with the stakeholder's comment and has included defintions and reporting requirements for Stability and Uniformity in Sections 3 and 7, respectively, of the ENERGY STAR Draft 2 Test Method for Laboratory Grade Refrigerators and Freezers and Ultra-Low Temperature Freezers (Draft 2 Test Method). |
| 6 | Definitions | Defrost | Semi-automatic defrost should be equivalent to manual defrost. | DOE agrees with this comment and has specified in Section 6.3 that, when testing for energy consumption, a product with Semi-automatic Defrost is tested in the same way as one with Manual Defrost. |
| 7 | Definitions | Other | Questioned whether DOE meant to specify that freezers house volatile reagents while refrigerators house non-volatile reagents. | DOE developed the definitions included in the Draft 2 Test Method based on descriptions found to describe products currently on the market. DOE welcomes additional feedback regarding any additions or changes that should be made to the current definitions. |
| 8 | Definitions | Refrigeration cycle | DOE should include definitions for cycle, defrost cycle, running cycle, and refrigeration cycle. | DOE has included definitions for "Refrigeration Cycle" and "Running Cycle" in Section 3 of the Draft 2 Test Method, as well as definitions of different types of defrost. DOE did not include a definition for "cycle" or "defrost cycle" because it believes that other definitions adequately cover this concept and wished to avoid redundancy. DOE requests comment on the definitions and asks stakeholders to suggest alternate or additional definitions. |
| 9 | Definitions | Steady state | Do you have a diagram of what you mean by refrigeration cycle? The reason for asking is I would see multiple refrigeration cycles within the 24 hour period so I want to make sure I understand how the .2°C is calculated. | |
| 10 | Definitions | Refrigeration cycle | DOE should clarify whether "refrigeration cycle" is synonymous with "cycle." A cycle seems to be defined as a 24 hour period but the industry definition of a [refrigeration] cycle is the sum of the a single instance of a compressor on and subsequent off time, not a 24 hr block, which contains many instances of compressor on/off. | |
| 11 | Definitions | Steady state - tolerance | Recommended that the temperature variation in the definition of steady state be changed from 0.2 °C to 0.5 °C due to limits on the accuracy and repeatability of measurements taken with Type T thermocouples, which have published limits of error of 0.5 °C. | DOE agrees with stakeholders that the Steady State tolerances were too stringent in the Draft 1 Test Method. Based on tolerances recommended by stakeholders and validation testing, DOE has updated the Steady State tolerance in Section 3 to 0.5 C for all product types. In response to comments about cycle instability and temperature variability in time, DOE clarifies that the steady state determination is based on the average of *all* measurements taken over the course of the measurement period. The temperature may vary within a cycle or over time, as long as the overall average stays within 0.5 C. |
| 12 | Definitions | Steady state - tolerance | The steady-state condition is too stringent and many labs would not need a unit that could meet this condition. The requirement could also prevent more energy-efficient units that have higher temperature fluctuations than allowed. Suggested that we could have two categories of lab grade units – high performance units and energy efficiency units (for the latter, increased fluctuations from the set-point would be permitted). | |
| 13 | Definitions | Steady state - tolerance | The definition of steady state may be difficult to meet for all products in this category. Suggested that 0.4 C may be more suitable because uniformity is addressed elsewhere. | |
| 14 | Definitions | Steady state - tolerance | In reference to definition of Steady State(AA) I also think that this is a very tight specification. I would think .5°C would be more reasonable. | |
| 15 | Definitions | Steady state - tolerance | The tolerance for steady state is very tight and allowing for a greater range would not impact the test results. I would recommend up to 2°F of tolerance to account for inherent cycle instability and measurement capability. The time period, allowing for cycle to cycle or 24 hours is adequate. | |
| 16 | Definitions | Steady state - tolerance | Temperature variability in time does not have to be +/- 0.2 degrees, especially for ultralow freezers. As mentioned on the call, variability of 2-3 degrees is more realistic and reasonable for energy efficiency. | |
| 17 | Definitions | Steady state - tolerance | Tolerance should be 0.5 C based on the limits of Type T thermocouples. | |
| 18 | Definitions | Steady state - tolerance | A wider deviation would be acceptable. At ultra low temperatures, there is no good science about what level of fluctuation matters. It matters at -20 but for ULFs, even a 5 degree swing wouldn't matter [to the contents of the freezer]. Thinks a 1 to 2 degree deviation would be ok [for the test]. | |

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| 19 | Definitions | Steady state | As part of the steady state definition, [the test procedure needs to] describe some Delta T from the setpoint. [For example,] if the setpoint is -80, the temperature would have to stay within some tolerance of that throughout the cabinet | The definition of Steady State is meant to define a point at which the unit's temperature is no longer changing (i.e. when pull-down has been achieved.) This applies regardless of the unit's setpoint. Deviation from the setpoint, on the other hand, is related to whether the unit meets an acceptable test condition tolerance - that is, whether the unit is operating sufficiently close to a common set point for its type so as to be able to compare it to other units operating at that set point. DOE included a tolerance for the set point temperature in Table 1 of the Draft 1 Test Method. DOE clarifies that the test condition tolerance denoted by the setpoint is based on the average of *all* measurements taken over the course of the test. |
| 20 | Definitions | Steady state | Disagreed with Thermo Fisher - If we're going to measure apples to apples, the average temperature needs to hit some tolerance regardless of what the display says. The display might not read accurately. | |
| 21 | Definitions | Steady state | DOE should clarify how data will be analyzed to determine steady state (sample raw data, calculation, graph, etc.) In the webinar, again requested clarification on the definition of steady state condition. | Determination of Steady State must be based on sample raw data taken immediately prior to performing the Energy Consumption Test. For each refrigeration cycle or 24 hour period, the average of all recorded temperature measurements must be calculated. If the calculated average of temperature changes less than 0.5 °C between periods, the unit is said to be in Steady State. |
| 22 | Defrost | Defrost adequacy assurance | The test method should describe how evaporator coils with shrouds or covers should be inspected. | Upon further evaluation, DOE does not believe the defrost adequacy assurance test provides any additional useful information and could significantly increase test burden. Furthermore, DOE does not believe it is necessary for determination of the product's daily energy use. As such, DOE has removed the defrost adequacy assurance test from the Draft 2 Test Method. DOE requests stakeholder feedback regarding the removal of this test. |
| 23 | Defrost | | Asked how adequate defrost will be checked for automatic smart/on demand defrost units. Proposed two defrost categories: assisted defrost and manual defrost. Manual defrost would be defined as any defrost system that requires manual interaction with the unit to initiate or terminate the defrosting of the unit. | |
| 24 | Defrost | | Many lab-grade refrigerators and freezers utilize a defrost system which is based on evaporator temperature which assumes ice accumulation, and may not trigger for weeks. | |
| 25 | Defrost | | Our ULT freezer will be running in the steady state for testing. Typically ULT freezers do not have a defrost cycle to remove frost or ice buildup from the evaporator. | |
| 26 | Door openings | Alternative methods | A $90^0$F ambient temperature with an empty cabinet eliminates the need for door openings as it puts a high load on the system. The higher ambient compensates for door openings, which may not be consistently done. | DOE performed investigative testing to evaluate the effect of both door openings and elevated ambient temperature on a unit's performance. DOE found that testing in an elevated ambient temperature did not consistently correlate with testing at the normal ambient temperature with door openings for the units that were tested. As such, DOE does not believe that testing with an elevated ambient temperature can adequately simulate door openings for the range of products covered by this test method. |
| 27 | Door openings | Alternative methods | Agrees that the test procedure should use a higher ambient condition in the test chamber to simulate door openings. (Just manufactures ULFs) | |
| 28 | Door openings | Alternative methods | It would be a sufficient measurement to test without door openings for refrigerators, freezers, and ULT's. We would recommend to use the standard ambient for testing. An alternative would be to put a fixed load in the cabinet. A 40, 50, or 60 watt load could be placed in the cabinet. The load could be turned on once the unit met steady state conditions. The fixed cabinet load would then give you a more repeatable energy usage for a given load. This is a standard way for testing ULT performance and could be adapted for refrigerators. Most manufactures call this reserve capacity. The load would have to be modified and tested for different size cabinets since 50 watts in a 5cuft cabinet would have much different effects than 50 watts in a 40cuft cabinet. | DOE believes that placing a heat load inside the ULF to simulate the heat load caused by door openings may not be the best approach because different products have different heat load characteristics due to their insulation, number of inner doors, etc. DOE believes it would be difficult and overly burdensome to specify a heat load fairly and in a way that is represenative of use for all products. DOE did not perform testing to analyze the effect, but asks stakeholders to share any data they may have. |
| 29 | Door openings | Inner doors | Concerned that if all inner doors are opened (at once) as part of the test protocol, it will not show the energy savings from having these doors in place. | DOE agrees with stakeholders who point out that opening all inner doors at once is not representative of actual use and has removed this from the test method.<br><br>DOE investigated two inner door opening methods and determined that opening only one inner door per outer door opening is likely to present a repeatable test method. DOE also believes this to be more representative of normal operation. As such, DOE has updated the door opening requirements in Section 6.2 of the Draft 2 Test Method to state that only one inner door shall be opened each time the outer door is opened. |
| 30 | Door openings | Inner doors | In regards to ULT we would not recommend opening all the inner doors or even one inner door. A typical user entering a ULT would at most only open one inner door to remove a sample unless they were emptying the entire cabinet for defrosting. In most labs they are careful about minimizing the time that they are in the cabinet so the more accurate energy usage is probably a steady state with no door openings. In the large freezer farms the samples are usually in for extended periods of time so door openings are minimal. When you open the door on a ULT since the air is so cold and dense the air instantly falls out of the cabinet. You can typically get one full volume of air exchange on a door opening. The volume of air lost or exchanged is based on the configuration of the inner doors and how tight the seals are on the doors. From a practical standpoint I am not sure how you could develop a mechanism to open the outer door then all the inner doors simultaneously without either costing a significant amount of money or interfering with the actual performance of the unit. The money to build the test fixture could be an issue for smaller privately owned business to afford, and test to the ENERGY STAR guidelines. | |
| 31 | Door openings | Inner doors | Choosing which inner door to open is important, so I recommend opening only the top door while the outer door is open. | |
| 32 | Door openings | Inner doors | Think [the inner door opening requirements?] are appropriate if they remain in the test procedure. | |
| 33 | Door openings | Other | Asked where table 1 values are applicable (with or without door opening) | The values in Table 1 apply to the overall average of all recorded interior temperature measurements over the entire test period, including door openings. |

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| 34 | Door openings | Other conditions | Door opening shall be performed in the most unfavorable normal operating condition. | DOE is unclear what the stakeholder means by "the most unfavorable normal operating condition." The ambient conditions have been set based on ASHRAE 72-2005 and are intended to be representative of normal use. DOE requests additional information on what "the most unfavorable normal operating condition" should be and how it would affect testing. |
| 35 | Door openings | Other measurements | Requested that the method include performance criteria for door opening; i.e., how [temperature] recovery from a door opening will be verified. | In Table 1, the Draft 2 Test Method specifies a set-point temperature at which the overall average temperature of the cabinet for the 24 hour test must remain. Further performance criteria are outside the scope of this test method. |
| 36 | Door openings | ULFs vs. lab freezers | Requested a sub-category for ULFs under door opening section since the rest of the document separates freezers and ULFs. | DOE has updated the door opening requirements in Section 6.2 of the Draft 2 Test Method to state that door openings for Laboratory Grade Freezers and ULFs shall be performed in the same way. DOE does not believe a separate sub-section is necessary for ULFs as the door opening method is the same as for Laboratory Grade Freezers. |
| 37 | Door openings | Yes or no | Recommended that we leave in door openings but report energy consumption under both conditions – steady state and door opening | Based on the various opinions among stakeholders as to whether to include door openings, DOE undertook additional investigative and validation testing to evaluate door opening repeatability. DOE conducted investigative testing with two different inner door-opening methods to evaluate repeatability. DOE also investigated the effect of an increased ambient temperature (32 C instead of 24 C) and compared it to the results of the door opening test to determine if this is a reasonable proxy. DOE evaluated the initial testing results as follows:<br><br>• If either of the door opening schemes is shown to be repeatable, then door openings should remain in the test method because DOE believes this to be most representative of actual use.<br>• If neither of the door opening schemes is repeatable, but the higher ambient produces comparable energy results, DOE would consider specifying a higher ambient temperature in the test method to simulate door openings.<br>• If neither door opening scheme is repeatable and the higher ambient does not produce comparable results, then DOE would not include door openings in the test method.<br><br>Based on the test results, DOE has tentatively concluded that the door openings are likely to provide repeatable results. Test results indicated that there was less than 3% variation in power consumption between cycles with either door-opening methods. Based on this testing, DOE has decided to continue requiring door openings during testing. |
| 38 | Door openings | Yes or no | The door opening methodology is not likely to occur in natural operating conditions but should assure a balanced standard for comparison. | |
| 39 | Door openings | Yes or no | The repeatability and reproducibility would be improved by testing products with no door openings with ambient temperature set to 24oC +/-1.0 °C. We also feel that it would be an easier and more accurate test because it would be hard to meet the specification on velocity and time with respect to the door openings as stated in 6.2 of Draft 1. | |
| 40 | Door openings | Yes or no | Recommended using steady state for ULFs to determine energy consumption, where door opening energy data is reported as additional energy consumption data. Both should be provided to the customer so they can understand the effect of the door openings on the energy consumption. | |
| 41 | Door openings | Yes or no | Door openings should be included because it will highlight the difference in energy consumption between chest freezers and upright freezers and because in her experience the majority of freezer doors, including ULFs, are opened multiple times per day.<br>However, if adding door openings to the test protocol would make it too complicated or costly to move the ENERGY STAR process forward, suggested that separate studies be done:<br>- Study to determine how much more efficient chest freezers are than upright units when door openings are included<br>- Study to determine the energy savings resulting from having inner doors in place. | |
| 42 | Door openings | Yes or no | Door openings should be eliminated from the test protocol and it is not necessary to increase the ambient to account for the lack of door openings. The primary purpose of the standard test protocol is for the consumer to be able to compare like units, not to provide expected energy consumption. Door openings are difficult to automate accurately and consistently, increase the test chamber space and complexity and add variability to the test results. It is also impossible to mimic real world conditions due to the large variance in usage patterns, ambient conditions and pack out levels normally seen in the field.<br>If door openings are to be required, they should match the ASHRAE standard and should be the same for refrigerators and freezers to reduce confusion and test complexity.<br>Drawer openings are not discussed in this protocol and should be clarified. | |
| 43 | Door openings | Yes or no | Door openings are important yet irrelevant without thermal loading of ultra-low freezers, humidity control, and weighted thermocouples. | |
| 44 | Door openings | Yes or no | We agree with some of the other stake holders to eliminate the door opening aspect of the test to reduce variability. We don't see any reason to have a higher ambient testing condition, eliminating the door opening will lead to a better comparison from manufacturer to manufacturer. The ANSI/ASHRAE Standard 72-2005 test utilizes units with simulated loads. These loads help to maintain the temperature and improve recovery during door openings. In the case of the test procedure for laboratory refrigerators and freezers the cabinet is empty so the entire volume of air is going to be lost during the door opening affecting the uniformity of the system. If it is left in the standard additional requirements, consideration needs to be given to how room airflow direction traverses the front of the cabinet when the door is open as well as a specification on how fast the door goes from a closed position to an open position so that the actual open time is equal for all units under test.<br>From a market standpoint the variance of door openings for customers are huge. We have customers in the same lab that open one refrigerator over 600 times a day and the refrigerator next to it they open 4 times a day. The applications are so varied I am not sure the value to the customer let alone the controls and costs that need to be developed and money spent to accurately test each individual configuration and size of cabinet. | |
| 45 | Door openings | Yes or no | Proposed reporting a test result with door openings and one without door openings. Commented that providing both test results could be a good balance between a steady consistent number for reporting, but could also provide the customer with a better perspective or number for door openings. | |
| 46 | Door openings | Yes or no | The door opening test and repeatability of it is a real problem for everyone. Doors are different sizes, different configurations. Really have to see about repeatability. | |

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| 47 | Drawers | | Drawers should not be cycled as part of the test protocol as this will adversely affect gross energy consumption and repeatability. First, thermocouple routing and durability is a concern due to the constant flexing of the TC wire. Second, thermocouples in a drawer will be removed from the refrigerated compartment and exposed to ambient air each time that the drawer cycles. This will cause significant fluctuations in temperature, particularly if an unweighted TC is used. | DOE agrees with the stakeholder and has specified that drawers shall not be opened due to the difficulty in maintaining the instrumentation. |
| 48 | Empty or loaded freezer | | The chamber should be tested unloaded. There are a few reasons for this. One is the unloaded condition is a worst case condition for the cabinet since there is no residual cold load to help with swings on the internal temperature of the cabinet. The second is many of these refrigerators are designed for storage of specific items, blood, pharmaceuticals, reagents, tissue, etc. So the internal racking, drawers, shelves are all different and configurable for each customer and each application. I am not sure how you could reasonably determine a configuration that would accurately represent normal usage by a customer. The third is that just placing the load in a cabinet causes inherent variation in test outcomes on cabinets. Placing loads in cabinets with internal fans could cause changes in airflow and this could affect the results of the temperature testing. Many customers actually validate the internal uniformity of the chamber using their own internal protocols based on the type of material they are planning to store inside of the refrigerator or freezer. | DOE has tentatively decided not to include loading of units in the test method because:<br><br>1. There is no representative set of contents. Manufacturers offer several different options in their catalogs – including different rack types and configurations, different boxes, etc., - and still other options are available from independent lab supply stores. There are also virtually infinite options for arranging and spacing racks and boxes within the unit. A study by Boston Biomedica, Inc., found that changing a ULF's rack configuration could cause temperature variation of up to 60 °C.<br><br>2. Loading the unit may not be repeatable. As mentioned above, even small variations in the configuration of the unit's contents could have large variations on performance. DOE would have to be certain that the configuration was exactly the same from lab to lab and from test to test.<br><br>3. Loading the unit would be burdensome to test. Manufacturers would have to supply racks and boxes to labs at extra expense, or labs would have to keep a set around for testing. A full set of racks and boxes can run to more than a thousand dollars. Furthermore, the lab would have to expend extra effort to place the thermocouples, potentially even drilling holes into the racks to route the wires. |
| 49 | Empty or loaded freezer | | Thermal mass should be included in freezers during testing, especially if door openings are included in the protocol.<br>- For ULFs, the manufacturer should provide racks for 2-inch boxes, and a water block that partially fills the box (25%-50%) could be placed in each box for testing.<br>- For refrigerators and non-ULT freezers, bottles of water could be used.<br>However, if this would be sufficiently complicated as to hinder the ENERGY STAR process, it should not be included. | |
| 50 | Empty or loaded freezer | | Measuring energy consumption should be done with an empty freezer with unweighted thermocouples to reduce test method complexity and because we believe that measurements in air are suitably representative of operating conditions. | |
| 51 | Empty or loaded freezer | | Recommended using unloaded freezers because there is no representative medium for testing loaded units. | |
| 52 | Empty or loaded freezer | | Recommended adding faux samples with tubes and bottles of water. | |
| 53 | Empty or loaded freezer | | I recommend ultra-low freezers be tested with a full set of racks and empty 2"cardboard boxes. While empty boxes do not provide much thermal weighting, they baffle air flow out of shelves during openings and accurately mimic user conditions. Keeping empty boxes is not a burden for testing companies as the boxes are universal. | |
| 54 | Empty or loaded freezer | | A loaded freezer is more homogenous than an empty freezer. Coming up with a standard way of loading is challenging, so his bias is towards empty freezers. | |
| 55 | Energy calculations | | Recommended using the AHAM test method to determine energy consumption at the category set point. (They included an excerpt from AHAM – the method involves two measurements – one higher than and one lower than the setpoint – and then find a linear fit to the energy consumption at the setpoint.) | DOE has tentatively decided not to require Laboratory Grade R/Fs to be tested at two temperatures. Previous validation testing of lab refrigerators and freezers showed that a single temperature setpoint was not overly burdensome to maintain and did produce repeatable test results.<br><br>DOE is requiring ULFs to be tested at two setpoint temperatures, -70 and -80, based on comments from stakeholders that both temperatures are common for these products and that for ULFs, the energy use is particularly sensitive to temperature setpoint. |
| 56 | Energy calculations | | A single temperature energy point is difficult to reproduce and would be very time-consuming to achieve. In household product a temperature of 38$^0$F is used as the "target" temperature, but testing is done at the midpoint setting of the control first. Then depending on whether the average temperature is above or below the "target" temperature you adjust the control to the warmest or coldest set point. Then by using the energy usage of the two points the target energy can be calculated. This makes it much easier to determine the energy of the product. | |
| 57 | Energy calculations | | Would the actual maintained setpoint be published as part of the testing procedure? 1.5 degrees can result in big difference [in energy use]. Since the eventual result is between -70 and -80, you could calculate the offset for -75. If the actual measured average temperatures are different from -70 and -80, the energy use at -75 could be calculated using a weighted offset. | The test method requires reporting of the overall average recorded temperature during the test. For ULFs, products are tested at both setpoint temperatures and an average of the energy consumption at both settings is calculated. |
| 58 | Energy measurements | | Procedure for measuring energy consumption needs to be specified – i.e. a watts transducer or voltage/current meter. | DOE believes that as long as the power meter meets all requirements in Section 4 of the Test Method then it is not necessary to require a specific set of instrumentation. |
| 59 | General | | Refrigerators, freezers, and ULT's must be subdivided into categories based on the relative design and designed purpose of the given unit. | This comment is unclear. DOE asks the commenter to be more specific about what subcategories are suggested. |
| 60 | General | | Maintaining common test standards and procedures for similar equipment provides significant benefit to manufacturers, third party test agencies and the DOE / EPA. | DOE has maintained common practices where possible; for example, this test method is based on ASHRAE 72, which is also used for DOE's Commercial Refrigeration Equipment Standard. However, each test method must also be specifically designed to address unique characteristics of the type of products being tested, which can result in different methodologies.<br><br>Also, many of the methods are similar across all types of lab R/Fs and ULFs, so DOE has consolidated these methods to avoid redundancy. Where ULF details differ, DOE has provided specific instructions for testing ULFs. |
| 61 | General | | ULFs should be separated completely in some manner so the details of testing are not confused with testing lab-grade freezers | |
| 62 | General | | Since energy testing guidelines have been already developed for household products, using already established test methods would be advantageous for testing Laboratory Grade refrigerators, refrigerator-freezers, and freezers. Our scientific product operates very similar to our household product with the exception of tighter control parameters to satisfy our scientific customers. | |

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| 63 | General | | Due to the many types of refrigeration equipment used in laboratories, there may need to be more specific test procedures for different product types. Manual defrost freezers should have a different test procedure than a frost free model. A refrigerator with no freezer might need to be tested differently from a refrigerator-freezer. This would be similar to the establishment of different product classes on the household side. | The test method specifies different instructions for units with different types of defrost. The test method also specifies different instructions for refrigerators, freezers, and ultra-low freezers. DOE requests additional feedback on potential oppurtunities to improve the current tests included in the Draft 2 Test Method. DOE also requests feedback regarding whether different compartments in combination refrigerator-freezers are powered separately or using the same power source. |
| 64 | Instrument specifications | TC calibration | Instruments should be physically calibrated at the actual temperature of the products being tested, not calculated from a different temperature which can cause inaccuracies. | The Draft 2 Test Method specifies that all temperature measurements must be accurate to within ±0.8 °C. DOE requests additional feedback from stakeholders regarding whether additional specifications are necessary. |
| 65 | Instrument specifications | TC calibration | It is necessary to make sure you either accommodate for the inaccuracies of the thermocouples by calibrating the variance out of the measurement or accommodate for the variance. If it is decided to use thermocouples to measure the temperature it may be a good idea to specify the minimum gauge of thermocouple used for testing. If the gauge is too small the response could be so fast that you may have errors associated with the measurement technique not real response of the system. This is more relevant in refrigerated systems with internal fans or blowers than the cold wall ULT's. | |
| 66 | Instrument specifications | | All temperature measurements according to the test method will be individual readings and thus +/- 0.8 °C would only apply. | DOE agrees and has removed mention of temperature difference measurements. |
| 67 | Instrument specifications | | Suggest a tolerance of +/- 1 C for TC measurements because typical TCs used for temperature measurement have a tolerance greater than +/- 0.8C. | Based on testing, DOE believes that the specified accuracy is appropriate. |
| 68 | Measurement intervals | | A shorter measurement interval than 3 minutes as stated in this section will be necessary in order to capture fluctuation in conditions. | DOE agrees with the stakeholders' comment and has updated the Draft 2 Test Method to state that all measurements be taken at one minute intervals. |
| 69 | Measurement Intervals | | Suggest that measurements be taken at 1-minute intervals, since defining characteristics of thermal performance can be missed using a 3 min sampling rate. | |
| 70 | Measurement intervals | | Recommended using a 1 min sampling rate as opposed to 3 min to ensure sufficient/accurate data collection. | |
| 71 | Minor issues | | Pointed out minor conversion errors in section 4 and section 5 | DOE has corrected all conversion errors and has removed mention of test simulators from the Draft 2 Test Method. |
| 72 | Minor issues | | Regarding air currents, 0.5 m/s does not convert to 45 ft/min. ASHRAE 72 calls for .25/49. | |
| 73 | Minor issues | | Line 356 mentions test simulator temperatures, but bare thermocouples are specified prior in the standard. | |
| 74 | Minor issues | | Please correct the tolerance in 6.5 A): 0.1 L = 0.0035 ft3; conversely 0.01 ft3 = 0.28 L. | |
| 75 | Operating modes | | Suggested that if a freezer has different modes (energy saving mode vs. High Performance mode) which both meet the stabilization testing requirements and thermal performance criteria, there should be multiple ratings, so the customer can understand the impact on energy consumption of cabinet temperature performance. | DOE requests further information regarding energy saving modes in products currently available in the market and how these modes affect product performance. |
| 76 | Operating modes | | For products, particularly ULFs, that have energy saving and performance modes, both modes should be tested. | |
| 77 | Other measurements | | Was interested in testing aspects of the freezers in a more realistic user environment: Specifically, the effect of multiple door openings/closings in various durations on temperature changes, frost buildup, and energy use, and if there are cold or warm spots. Frost, in particular, can affect freezer performance. | This ENERGY STAR Test Method is intended to evaluate the energy consumption of a unit under normal conditions and not as an investigative test method. Additional tests are outside the scope of this Test Method. |
| 78 | Other standards | | Regarding stability, as stated above the French standard for testing refrigerated cabinets NF X15-140 is a good reference to address many of the issues surrounding the actual measurement technique. | DOE was previously unaware of this standard and requests additional stakeholder feedback regarding the stabilization measurement techniques included in it. |
| 79 | Pre-test configuration | Power supply | For models with more than one variant based on voltage (115V and 208-230V), all variants should be tested. | DOE has updated the voltage tolerances in the Draft 2 Test Method to be consistent with ASHRAE 72. The test method allows for testing units with different operating voltages. DOE agrees that models should be tested with a power supply consistent with their operating voltage. Certification of different variants of models will be addressed in the future Energy Star Specification. |
| 80 | Pre-test configuration | Power supply | ANSI/ASHRAE Standard 72-2005 (Method of Testing Commercial Refrigerators and Freezers) prescribes that the power supply shall be maintained at the rated voltage +4.0% and rated frequency of + 1.0%. A rated voltage +5.0% is more realistic [than the test method, which specifies +/- 1V? how was that chosen?] | |
| 81 | Pre-test configuration | Power supply | Questioned the use of a 115 Volt power supply and asked if a unit with a different operating voltage (e.g. 220 V at 60 Hz) would be automatically certified after the 115 V version is tested? | |
| 82 | Pre-test configuration | Power supply | Asked for clarification on whether voltage tolerance is for non-running or loaded state, whether this is throughout the whole test, and how it is verified. Suggested a tolerance of +/- 3% from nominal voltage. | |
| 83 | Pre-test configuration | Power supply | The majority of ULFs operate from 208 to 230 VAC with internal boost transformers. Power for these units should be specified as standard 208VAC 60Hz, the norm for the US market. For ULFs with two compressors, the voltage should be verified under full load with both compressors running. | |

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| 84 | Pre-test configuration | TC placement | Recommended that testing should be done on the manufacturer-prescribed configuration of the shelves, regardless of number or location, where each shelf or drawer can be required to utilize the 5-thermocouple configuration, to more accurately reflect the intended use. | DOE has specified thermocouple placement to optimize coverage of the entire cabinet volume, and to be generally consistent with the manufacturer's shelf and/or inner door configuration, but also to minimize the number of thermocouples that must be installed while still covering these criteria.<br><br>DOE agrees that thermocouple placement should be away from the shelf, walls, or floor of the unit so that the thermal mass of these structures does not affect the thermocouple reading. DOE believes that 3" is sufficient for all product types, but requests any stakeholder data that shows another distance may be more appropriate.<br><br>Regarding the temperature stratification associated with chest ULFs, DOE believes that adequate thermocouple placement should generally provide coverage of all areas of the ULF that would normally hold products or samples. DOE requests further comment on whether chest ULFs are typically loaded to within 3 inches of the top, or if not, how close to the top they are loaded. |
| 85 | Pre-test configuration | TC placement | Thermocouple placement should be [at least?] 3" above and away from the plane (sides and bottom) of the shelf or drawer to eliminate influence of thermal transfer from the cold medium. The bottom of the unit can be used as a shelf and should get a TC grid. | |
| 86 | Pre-test configuration | TC placement | Using fewer thermocouples in testing may work just as well as testing with more thermocouples. | |
| 87 | Pre-test configuration | TC placement | It is unclear how to place thermocouples when adjacent shelves exist. If 2 shelves are adjacent, are 8 tc's used or are 10 TC's used? | |
| 88 | Pre-test configuration | TC placement | Regarding TC locations for units with shelves, requested a figure to clarify the TC placements between and on adjacent shelves. | |
| 89 | Pre-test configuration | TC placement | Number of thermocouples: Three per shelf is adequate on top, bottom and middle shelves for closed door tests: one in center; one in a front corner, one in a back corner. | |
| 90 | Pre-test configuration | TC placement | Thermocouple placement appears to be appropriate because it ensures that TCs are not in direct contact with shelves, walls, or other components. | |
| 91 | Pre-test configuration | TC placement | Are there any accommodations for small units under 5cuft? Many of these units only have two shelves but the specification calls for 3 layers of thermocouples. Do we still need three layers or can we just have one at the center? | |
| 92 | Pre-test configuration | TC placement | Helmer would support the same placement of thermocouples in ULT's as recommended for refrigerators and freezers. | |
| 93 | Pre-test configuration | TC placement | For upright freezers with shelves, freezer shelves should be placed evenly spaced in the standard configuration based on the inner doors. This is the configuration the customer would use most often, as it affords the optimum access to the storage volume. This is opposed to positioning the shelves in the extreme positions in freezers where customers may choose from a range of shelf locations. Thermocouple placement planes should still be located 1" above the topmost, central, and bottom shelf or bottom of the freezer if this acts as a storage plane. | |
| 94 | Pre-test configuration | TC placement | Due to the inherent temperature stratification associated with ULT chest freezers, we suggest moving the 8 top temperature measuring locations from 3'' to 6'' diagonally away from the corners of each measuring plane. | |
| 95 | Pre-test configuration | TC Routing | The method should specify a process on how the thermocouple probes should be routed into the units. If transmitting probes are not used, the probes should be routed into the unit through an access port (if available) which should then be sealed. Routing TC wires through the gasket can cause erroneous results because these units tend to draw in warm air as the cold air contracts inside the unit. | DOE agrees that thermocouples should be routed into the cabinet through an access port whenever possible and has updated Section 4 of the Draft 2 Test Method to specify this. DOE requests stakeholder feedback regarding an appropriate way to route thermocouples into cabinets without an access port. |
| 96 | Pre-test configuration | Test setup | ULT freezers should be tested in the standard product configuration without miscellaneous accessories and product options, such as backup cooling systems, that do not affect the test for energy efficiency. | The test method specifies that units must be empty except for shelves and drawers that are sold with the unit. Units with different types of shelves must be tested separately. Currently manufacturers must report all accessories and product options that are applicable to the tested unit. Certification of different variants will be addressed under the ENERGY STAR specification. DOE requests additional stakeholder feedback regarding how variations in shelving may impact energy consumption during normal operation. |
| 97 | Pre-test configuration | Test setup | Asked if a unit comes in different options – wire shelves, solid shelves, drawers, or a combination – is each possibility certified independently? It would be better to define an empty cabinet to preserve the original design. | |
| 98 | Pre-test configuration | Test setup | Asked whether all shelving or basket options that could improve energy efficiency would be required to be tested independently, and recommended units be tested without the options unless option is needed to meet intended performance criteria. | |
| 99 | Pre-test configuration | Test setup | Line 238 under pre-test configuration states that each option needs to be tested. I am not sure what that really means. Helmer sells a standard configuration but customers are able to modify that unit with any choice of racks, shelves, drawers, or any combination of these in a single unit. I am not sure how to handle this specification for our refrigerators and freezers. | |
| 100 | Reporting requirements | Energy per box | Recommended that power consumption be reported in average Watts per volume, where volume can be expressed in either cubic feet or standard 2" (5 cm) cardboard boxes that fit into the manufacturers' racks, and are part of the catalog advertised capacity. This will discourage purchasing of under-counter units that have terrible energy efficiency due to scale, for example. It will also make incentivizing energy efficiency very simple to set benchmarks. For ultra low freezers, this is also an advantage of using the racking capacity as the volume. It is an integer value verified by counting the racks and shelves, and it accurately reflects the usable volume of the freezer. | The test method requires reporting of the energy consumption and the volume in cubic feet because this can be compared across all manufacturers and units. DOE does not propose to require manufacturers to report the box capacity. A final energy efficiency metric will be included in the ENERGY STAR Specification for these products. |
| 101 | Reporting requirements | Energy per box | I also would not have some measurement based on box capacity. First ULT's are used for many types of storage, reagents, cells, bone, tissue and other biologics. The box is common but not exclusive and currently many of the larger ULT manufactures are marketing by box capacity so this may give them an unfair advantage in the market if Energy Star® comes out with a box/energy capacity measurement. I think using the standard for measuring internal volume should be utilized, as suggested by the current draft standard. | |

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| 102 | Reporting requirements | | Ambient temperature must be reported in the room and at the intake grill. If the temperature of air crossing the condenser coil could be reported, that would have additional value. | The ambient temperature measurement locations included in the Draft 2 Test Method align with those in ASHRAE 72-2005, and DOE believes these are sufficient for ensuring that the ambient conditions in the test room meet the specifications included in Section 4 of the Test Method. As such, DOE has not included an additional ambient temperature measurement at the intake of the condenser. |
| 103 | Reporting requirements | | In the reporting requirements, proposed adding a performance column and three categories for measuring performance.<br>1) "Regulated" category should be for units designed strictly for the regulated market (i.e. Blood banks)<br>2) "Validation" market for units designed around customer internal validation protocols or other published guidelines i.e.. vaccine and enzyme storage, pharma industry etc.)<br>3) "General" for all other lab application there cabinet temperature performance are more lax. | In Section 7 of the Draft 2 Test Method, DOE has required reporting of certain performance metrics that it believes can be used to determine compliance with various customer requirements (uniformity, stability, etc.). However, it is outside the scope of the Test Method to require different methods and reporting requirements for different markets or customers. Any differentiation between product types for ENERGY STAR Qualification will be addressed in the ENERGY STAR Specification. As such, any comments regarding this issue should be submitted to EPA upon publication of the first draft of the Specification. |
| 104 | Reporting requirements | | Manufacturers should not report a weighted average of -70 C and -80 C for ULFs because many end users require either one or the other, and the majority store product at -80 C. Many ULFs do not perform as well at -70 C as -80 C related to uniformity. If the unit is tested at both temperatures, results from both temperatures should be reported separately including uniformity results, so customers can make an informed decision based on their specific storage requirements. | DOE has updated Section 7 of the Draft 2 Test Method to require reporting of test data including energy consumption and temperature Uniformity and Stability at each set point temperature (-70 and -80°C) as well as the weighted average of both tests. |
| 105 | Reporting requirements | | Requested that manufacturers also provide the power factor. | DOE is open to requiring the reporting of power factor but requests additional stakeholder feedback regarding the significance of power factor data to a unit's measured energy use, whether power factor varies during the course of normal operation, and, if so, at what point in a product's normal operation it should be measured. |
| 106 | Reporting requirements | | For lab grade refrigerators and freezers in the range of -20 and -30 C, I recommend that power data of typical ENERGY STAR residential or commercial refrigerators and freezers be provided next to the lab grade models. This will show the relative advantage of using a different type freezer or refrigerator. | DOE selected the temperatures for testing, specified in Table 1 of the Draft 2 Test Method, based on what it believed were the most commonly used settings for each product type. DOE requests additional stakeholder feedback regarding these temperatures and any others that may be more commonly used in normal operation. Furthermore, any reporting of values not measured during the Test Method will be addressed in the ENERGY STAR Specification. As such, further comments should be submitted upon publication of the first draft of the Specification. |
| 107 | Reporting requirements | | I recommend that manufacturers provide the energy profile of each freezer at -60, -70, -80, and -86 °C. Minus sixty is twenty degrees below the glass point of water and little additional crystalline deformation is likely below this temperature. It is already used in some applications. Freezer use at -60 half the energy as -86 in some models. The additional measurements (-60, -86) would not need to pass precision or stability criteria such as -70 and -80. | |
| 108 | Scope of ENERGY STAR Specifications | | Energy efficiency standards and high efficiency modes need to be included in chromatography refrigerators, which we have also tested as very inefficient. They are needlessly purchased sometimes when stringent temperature settings are not needed. | As part of the ENERGY STAR Specification, different energy consumption requirements will be set based on product type. DOE has included definitions for three different product types in Section 3 of the Draft 2 Test Method. DOE requests stakeholder feedback regarding these definitions and whether additional product types should be included. |
| 109 | Scope of ENERGY STAR Specifications | | Excluding ULFs from the scope of ENERGY STAR specifications would significantly reduce the impact of the program because ULFs are one of the greatest energy consumers in a laboratory environment. | |
| 110 | Scope of Test Method | | Chromatography units should be removed from pharmacy category as it is designed to support heat generating equipment inside and will require more energy to maintain tight cabinet performance requirements | |
| 111 | Scope of Test Method | | DOE should verify that the procedure applies for reciprocating systems only and not Stirling refrigeration systems | The test method does not distinguish between different ULF technologies. Currently, Lab grade refrigerators, freezers, and ULFs that utilize Stirling refrigeration systems would fall within the scope of the test procedure. |
| 112 | Scope of Test Method | | -40 C lab grade freezers are missing from the procedure. These units are essentially the same as ULFs, except they have a single stage compressor instead of a two-compressor cascade system. However, they use the same chassis as a ULF which has good insulation. This would likely cause these units to be more efficient than many other lab grade freezers. | DOE has added -40 freezers to the scope of the test method based on stakeholder comments that they use the same type of technology and are used for similar applications as other types of lab grade refrigeration equipment. DOE has not included cryogenic mechanical freezers in the scope of the Test Method as they do not operate in the same manner as the products currently included. However, DOE requests additional stakeholder feedback regarding cryogenic mechanical freezers and any other product types that should be considered for inclusion in this ENERGY STAR Program. |
| 113 | Scope of Test Method | | Suggested that the temperature range of ULFs be expanded to include cryogenic mechanical freezers at -160 C as well as -40 C freezers, to cover the entire range of products. | |
| 114 | Temperature reporting | | The average of the 5 TCs in a given section (shelf/drawer/etc.) should be reported along with the minimum and maximum measurement for the given section as well. This will ensure proper temperature fluctuation across the cabinet. (If the purpose of lines 366-367 is to ensure stable temperature in each section of the unit.) | DOE has updated Section 7 of the Draft 2 Test Method to require reporting the average, Uniformity, and Stability of all measurements taken during the test and believes that additional reporting requirements are unnecessary. DOE requests further stakeholder feedback regarding the benefit of reporting temperature values at a more granular level. |

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| 115 | Temperature set-points | -30 vs. -20 | Many lab-grade freezer models operate at both -20 and -30, so should be considered for submission in both categories. | DOE agrees with stakeholders' comments and has continued to keep -30 and -20 as separate categories for purposes of testing in the Draft 2 Test Method. For products that are capable of operating at both temperatures, DOE requests feedback regarding whether these units are operated more frequently at one temperature versus the other. For purposes of establishing specifications, the future ENERGY STAR specification development process will address these products. |
| 116 | Temperature set-points | -30 vs. -20 | For set points on freezers I would recommend both -20°C and -30°C since both are used for different applications by customers. | |
| 117 | Temperature set-points | -30 vs. -20 | Thermo Fisher sells less -30s than -20s, but there is a market for -30s. -30 is auto defrost. When they're in their defrost cycle they're warming. A lot of -20s are manual defrost. Appropriate to have both categories, set at temperature they're marketed at. Plasma freezers have documented protocols with -30 automatic defrost. But people in academia using enzymes, absolutely they want a manual defrost and a -20 freezer. | |
| 118 | Temperature set-points | Other standards | The temperature average for the commercial refrigeration standard is 38°F +/- 2°F or 0°F +/- 2°F. It would be preferable to remain consistent where possible with other similar standards. | DOE has chosen the set point temperatures included in Table 1 of the test method based on how these products are marketed. Furthermore, the Federal Regulatory Program for Commercial Refrigeration Equipment (CRE) specifically excludes products that are designed and marketed for "medical, scientific, or research purposes." Based on this, DOE believes that the products being covered by this test method are not covered by the DOE CRE program, so there is no consistency issue. As such, DOE has made no updates to the set point temperatures used for testing. |
| 119 | Temperature set-points | Set-point vs. operating temperature | Regarding how to test units that do not have a clear identification of operating temperature, recommended testing at the pre-defined category that is the lowest operating temperature that can be achieved. | DOE agrees with the stakeholders' comments that products without a clearly identified operating temperature should be tested using the lowest temperature setting provided in Table 1 and has updated the Draft 2 Test Method to state as such. |
| 120 | Temperature set-points | Set-point vs. operating temperature | Recommended using the manufacturer's setpoint and not the intended use because it is the user's prerogative as to what set point they use. | DOE requests additional clarification regarding what the stakeholder means by "manufacturer's setpoint." Is this intended to mean the default set point temperature upon shipment? |
| 121 | Temperature set-points | Set-point vs. operating temperature | There should be a requirement to make sure that the average cabinet temp was actually at -80 or -70 or within some tolerance band. Testing should make sure the average temperature is at -80 if you set a ULF at -80. | DOE has clarified in the Draft 2 Test Method that "set point temperature" refers to the temperature as measured by the test instrumentation, not the unit's own temperature control. |
| 122 | Temperature set-points | Set-point vs. operating temperature | Table 1 includes a set point temperature. This is not necessarily a setting on the unit. A temperature control may have letters, numbers, tic marks or actual temperature values. It is sufficient to state the thermocouple average temperature as this will dictate the position or setting of the temperature control. | Setting requirements on the unit's particular method of temperature control is outside the scope of the test method. The test method requires reporting of the conditions under which the unit is tested, including certain metrics of the unit's operating temperature during the test. The customer must decide whether this unit meets their needs. |
| 123 | Temperature set-points | Specific applications | Blood banks are required to also meet standards by AABB. AABB has a temperature requirement for blood banks that states the temperature inside the cabinet needs to be between 1°C and 6°C. This is a minimum maximum on the uniformity of the cabinet. In the proposed standard (table 394) the average set point temperature is 4°+/-1°C. The set point is within the specification but the actual temperature swings during the test could be outside the AABB specification. If this happened you could have a cabinet with a low energy usage but did not meet the AABB specifications for a blood bank. I would propose that for blood banks that none of the temperature measurements during the test can be outside the AABB specifications. | The specifications of other certification bodies are outside the scope of the test procedure. DOE has attempted to specify what data must be recorded during the test procedure such that the recorded data would be sufficient to determine whether the unit meets the user's needs (including compliance with other specifications). |
| 124 | Temperature set-points | Tolerance | Recommended that DOE drop the requirement that the average of all thermocouples meet a tolerance of +/-1.5 °C, which would require the compressor to run almost 100% of the time. | DOE clarified in the test method that the test condition tolerance of +/- 1.5 °C applies to the average of all measurements taken over the course of the test. Normal temperature fluctuations caused by compressor cycling are acceptable as long as the overall average over time is within +/- 1.5 °C of the test point. |
| 125 | Test conditions | Ambient conditions | Given the ambient temperature probe locations, the door opening test for ULFs and -30 °C freezers could cause a downward spike in the ambient. This should be acceptable as long as ambient temperatures quickly return to the test conditions. | The ambient temperature setpoint of 24 °C is the same as that specified in ASHRAE 72, as recommended by stakeholders. |
| 126 | Test conditions | Ambient conditions | Ambient conditions should be kept consistent with the established ASHRAE 72 standard to allow for maximum test room utilization and efficiency. | |
| 127 | Test conditions | Ambient conditions | The test method should compare apples to apples, regardless of what temperature we operate at. Would rather standardize [the ambient dry bulb temperature?] at 24 °C which is more meaningful for customers. If the door's not open, humidity won't matter. | |

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| 128 | Test conditions | Humidity | If the test method does not include door openings, wet bulb and dry bulb are not important either. Humidity may not make much difference with no door openings. | DOE agrees with stakeholders and has specified that ambient conditions must be in accordance with those listed in ASHRAE 72. |
| 129 | Test conditions | Humidity | Would recommend we maintain standard dry bulb and wet bulb ambient conditions per ASHRAE just for consistency across test results and products. | |
| 130 | Test conditions | Humidity | In his work with an ASHRAE committee, they found that if dry bulb and wet bulb conditions are not controlled, this can have a 10-15% variation on energy consumption. | |
| 131 | Test conditions | Lighting and radiant heat | Lighting and radiant heat specifications are not necessary for ULFs. | DOE agrees with stakeholders' comments and has eliminated lighting and radiant heat requirements from the Draft 2 Test Method as it expects these to have no measurable effect on the results. |
| 132 | Test conditions | Lighting and radiant heat | Many new testing facilities utilize LED lighting (as opposed to fluorescent lighting) which allows for a tighter control on airflow and temperature dynamics within the test facilities. DOE should instead allow for any type of lighting with the prescribed illumination characteristics but require a thermal load be added if the illumination source does not emit the same amount of energy into the room as the equivalent florescent setup. This will allow for multiple lighting scenarios all affecting the room conditions equally. | |
| 133 | Test conditions | Lighting and radiant heat | The radiant heat requirement is unnecessary except for chromatography refrigerators. | |
| 134 | Test conditions | Lighting and radiant heat | Having performed hundreds of comparative energy tests, lighting and radiant heat have not been shown to impact the results. Utilizing the white gloss finished surface as indicated in the standard significantly reduces test chamber throughput due to the excess space occupied by the white surface. It would simplify the procedure for manufacturers if this condition were removed. | |
| 135 | Test conditions | Lighting and radiant heat | Radiant heat requirements are not needed as part of testing for efficiency. Most added samples in a research setting are small in thermal mass, and the ability of a freezer or refrigerator to pull down the temperature is not relevant to sample size. | |
| 136 | Test conditions | Lighting and radiant heat | It is our recommendation to eliminate the requirements for lighting and radiant heat as described in 4. Test setup. Line 142 – 149. | |
| 137 | Test conditions | Lighting and radiant heat | Lighting and radiant heat requirements are not necessary | |
| 138 | Test conditions | Other | Customers typically set up freezers closer to the wall than 1500 mm | DOE requests further information from the stakeholder regarding what effect, if any, the location of the unit in relation to the test room's walls would have on performance. |
| 139 | Test conditions | | Humidity, temperature gradients, radiant heat, and lighting have little bearing on the product. However, it is important to establish ambient dry bulb temperatures within +/- 1 °C during the duration of the test. Air current specifications should remain because they affect the door opening tests. | DOE has specified in the Draft 2 Test Method that the ambient dry-bulb temperature shall be 24 °C +/- 1.0 °C during all testing. DOE has also retained the air current specifications in the Draft 2 Test Method. |
| 140 | Test duration | | When a freezer has reached equilibrium, 8-20 hours is an adequate time interval of measurement. | DOE has specified a 24-hour test because it allows sufficient time to include a period of door openings as well as a period when the unit is not being opened nor being affected by previous door openings. |
| 141 | Volume measurement | Box capacity | For ULFs, in addition to volume, manufacturers should report the number of 2-inch freezer boxes that will fit in the freezer when using the freezer racks that come with the freezer. | DOE understands that a common method of reporting useable volume for these products is the number of 2" boxes that will fit into the unit. However, DOE is currently unaware of a method to verify the manufacturer-reported value that would be repeatable and low-burden. As such, DOE has specified in Section 5 of the Draft 2 Test Method to determine useable volume using the method specified in HRF-1-2008, to align with other DOE and ENERGY STAR Refrigeration Programs. However, DOE is interested in stakeholder feedback regarding any available methods for verifying the 2" box capacity of a unit. |
| 142 | Volume measurement | Box capacity | The standard unit of storage for scientists is the 2” box and the number of boxes is reflective of the usable volume for scientists. If we want to get energy efficiency per volume, would suggest that box [capacity] information be included as supplemental information. | |
| 143 | Volume measurement | Box capacity | Could also use 3” vials, 4” vials, and microplates. Covers different sample storage needs. 2” vials and 2” boxes are the most commonly stored sample. | |
| 144 | Volume measurement | Box capacity | Understands the need to utilize the fact that 2” boxes are more popular, but not sure she understands why there is a need to include strict measurements in this type of test., These tests should be as simplified as we can, so there’s less error. | |
| 145 | Volume measurement | Box capacity | From a management point of view, researchers want to know overall storage efficiency. In the end what’s the most efficient way to store samples. Knowing the volume of the freezer, one can plot energy use in W/CF or W/box. | |

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| 146 | Volume measurement | CAD drawings | Estimation of volume could be done by physical measurement or CAD drawing for ULT freezers. We would be able to supply the CAD drawings confidentially. | DOE has updated Section 5 of the Draft 2 Test Method to specify the use of HRF-1-2008 when determining a product's useable volume. DOE agrees that CAD models can be used to determine the useable volume, as long as measurements and calculations made based on drawings meet the requirements specified in HRF-1-2008. |
| 147 | Volume measurement | CAD drawings | Did not object to use of CAD models for volume based measurements, but tolerance within the CAD model must be specified to ensure accuracy. | |
| 148 | Volume measurement | CAD drawings | Did not disagree with using CAD files but stated that we need to use a consistent measurement of AHAM volume. | |
| 149 | Volume measurement | CAD drawings | CAD diagrams are available and dimensionally accurate. | |
| 150 | Volume measurement | CAD drawings | The use of 3D CAD data for other types of analysis is very common. I don't see an issue with the certified body using that for calculating the internal volume but it would require them to have compatibility with the specific cad systems. There are probably 10 different 3D CAD systems used in industry and not sure how portable the outputs are for all the systems. If we don't transfer data in a native format we transfer 3D cad data using a STEP file format. I think you would also leave in the AHAM volume measurement incase the CAD data was not available. | |
| 151 | Volume measurement | CAD drawings | We have no problem sharing the CAD drawings. | |
| 152 | Volume measurement | How to calculate volume | Section 6.5 should distinguish between freezers with and without inner doors | DOE agrees that a standard method should be used when determining the useable volume of products. As such, DOE has updated Section 5 of the Draft 2 Test Method to specify the use of HRF-1-2008 when determining a product's useable volume. |
| 153 | Volume measurement | How to calculate volume | Many units with a forced air design recommend that product not be placed against walls, and many upright units contain a maximum load line limit where product should not be stored above the load line. Load lines should be taken into account when calculating capacity. Also, for ultra-low freezers with inner doors, total capacity should be calculated up to the rear of the inner doors and not to the rear of the outer door. | |
| 154 | Volume measurement | How to calculate volume | Some racking would allow using the space in front of the shelf to store samples. Therefore, this extra space should be included in net usable volume. | |
| 155 | Volume measurement | How to calculate volume | Volume measurements should follow an established guideline. The AHAM standard would be preferable for manufacturers and third party test agencies since this is already used extensively for other energy programs. | |
| 156 | Volume measurement | Tolerance | It is more reasonable to have a volume tolerance of +/- 0.5% than 0.1 L based upon ULT construction methods (sheet metal and polyurethane foam insulation) and manufacturing tolerances. | DOE agrees that the tolerance provided in the Draft 1 Test Method was too stringent. Based on these and other comments, DOE has updated Section 5 of the Draft 2 Test Method to specify the use of HRF-1-2008, which requires reporting to the nearest 0.1 cubic foot (1.0 liter), when determining a product's useable volume. |
| 157 | Volume measurement | Tolerance | The measured volume precision is unnecessarily stringent. When energy measurements will have 3-5% precision, seeking +/- 0.5% precision is unnecessary. | |
| 158 | Volume measurement | Tolerance | We feel the tolerance is too tight. [The tolerance should be] +/- 0.5% because of manufacturing tolerances | |
| 159 | Volume measurement | Tolerance | 0.5% sounds extremely tight also--it would be a much tighter precision than physical measurements would be. +/- 2% would be fine. | |
| 160 | Weighted TCs | | Measuring energy consumption should be done with an empty freezer with un-weighted thermocouples to reduce test method complexity and because we believe that measurements in air are suitably representative of operating conditions. | DOE conducted testing to determine whether to use weighted or unweighted thermocouples and use the data to evaluate whether the test method should be modified.<br><br>• If the results show that there is no significant difference between weighted TCs and bare TCs, the method shall specify bare TCs to minimize test burden.<br>• If there is an observable difference, DOE would will examine the data to determine whether the test is more likely to be repeatable with weighted or bare TCs, and modify the test method as needed.<br><br>Based on the evidence, DOE found that weighting the TCs had minimal effect on the overall average temperature of the cabinet measured over the course of the test. DOE only requires that the average of all temperature measurements taken over the course of the test be within the tolerances of each Set-Point Temperature specified in Table 1. As such, DOE has retained the specification that un-weighted TCs be used during testing. |
| 161 | Weighted TCs | | Recommended using open air thermocouples. | |
| 162 | Weighted TCs | | Using bare thermocouples will make it much more difficult to maintain temperatures in the ±1°C range, thus requiring more energy due to more compressor on-time. For household refrigeration testing, a 1.125 x 1 inch brass slug is used as a mass to give a more stable temperature. Since we are trying to achieve an energy usage number and not necessarily looking at performance, it is more important to develop a consistent method of testing regardless of the product to be stored. | |
| 163 | Weighted TCs | | I recommend thermocouples be inserted through the lid of a 1.5 ml microcentrifuge tube and into 0.5 ml water or 0.8 ml wax to simulate the smallest sample in a freezer. Samples would normally have additional thermal buffering in the form of racks o boxes. I recommend that one thermocouple-vial sensor be placed next to the manufacturer's temperature sensor, and one on a front corner of the top shelf, which is most subject to temperature excursions | |
| 164 | Weighted TCs | | The chamber could be tested with either weighted or unweighted thermocouples. The size or weight of the thermocouple load would be important. If it is decided to weight the thermocouples I would not use extreme amounts of weight. A very good reference for testing refrigerated units is a French standard. The standard is NF X15-140 (www.afnor.org). It has some excellent references on temperature measurements, allows for weighted thermocouples, and explains how to address the inaccuracies associated with the sensors used to measure the temperature. | |
| 165 | Weighted TCs | | Submerging thermocouples in water should be considered so that the conditions experienced by the majority of sample types can be simulated. | |

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| 166 | Weighted TCs | | Un-weighted bare thermocouples provide large variances in individual temperature readings. For consistency and stability of data, a weighted thermocouple, such as used in NSF testing, should be specified. | |
| 167 | Weighted TCs | | Recommends including a weighted TC in a standard sample vial. Specifically recommends 1 thermocouple in a micro-centrifuge tube in wax or water. Might smooth out some of the variability inherent in an empty freezer and would be more consistent with what a full freezer would experience. | |