

Dear Energy Star Testing Reviewers,

I recommend that power consumption can be reported in average Watts per volume. This will make these tests accessible across all makes, models and sizes. Volume units can either be Cubic Feet (CF) or standard 2" (5 cm) cardboard box 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. For an ultra low freezer this value is 30-60 W/CF and 1-3 W/box

Additional Data Requested from manufacturers: Power Factor;

For lab grade refrigerators and freezers in the range of -20 and -30, 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 relative advantage to using a different type freezer or refrigerator.

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.

**VOLUME PRECISION:** The measured volume precision is unnecessarily stringent. When energy measurements will have 3-5% precision, seeking +- 0.5% precision is unnecessary, as mentioned in the conference call.

**TEMPERATURE STABILITY.** I agree with Dr. Ramirez that temperature variability in time does not have to be +- 0.2 degrees, especially for ultra low freezers. As mentioned on the call, variability of 2-3 degrees is more realistic and reasonable for energy efficiency.

**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.

**WEIGHTED THERMOCOUPLES:** 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 or 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. I cannot recommend a temperature stability for this sensor at this time as there is no data to share.

When a freezer has reached equilibrium, 8-20 hours is an adequate time interval of measurement. 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.

**RADIANT HEAT response:** I do not believe this is necessary as part of core 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. It is rarely like a commercial food cooler that needs to chill a side of beef in an hour. This is especially true in cabinets that have no active circulation.

**DOOR OPENINGS:**

This is important yet irrelevant without thermal loading of ultra low freezers, humidity control, and weighted thermocouples. As mentioned below. Choosing which inner door to open is important, so I recommend opening only the top door while the outer door is open.

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.

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.

Thank you for your efforts in

Sincerely yours,  
Sustainability Manager 530-752-2075  
Office of Environmental Stewardship and Sustainability  
University of California, Davis 95616