

Description of test procedure for professional kitchen refrigerators and freezers according to EN441

Summary: This is a technical note that can help technicians specify the test procedure. The note might appear incomprehensible to those who previously have not tested kitchen cabinets. If detailed test conditions are of no interest, this note can be left out.

The objective of this note is to give a popular and readable description of test procedures. The tests shall take place according to EN441, and the descriptions in that specific standard are the ones that are valid.

The tests connected with energy consumption and energy efficiency take place in climate chambers at a certain ambient temperature and humidity ("climate class 4"). The cabinet will be filled with test packages and tested with door openings as described in the standard. The different temperatures and the energy consumption will be registered and a test report will be prepared as specified in the standard.

Test procedure

Professional kitchen refrigerators and freezers are tested according to EN441 "Refrigerated Display Cabinets" although the standard strictly speaking does not cover much more than refrigeration display cabinets. All tests and test methods known to Danish Technological Institute refer to EN441. That test standard is similar to the corresponding standard for domestic refrigerators and freezers (EN153), but there are also differences.

According to EN441, it is possible to choose different climate classes (e.g. climate class 4: 30°C, 55% relative humidity), whereas EN153 has a certain climate test (+25°C, 60% RH) – corresponding to climate class 3 in EN441.

Climate class 4 (30°C, 55% RH)

In Great Britain testing is carried out according to climate class 4 (30°C, 55% RH), as it is believed that climate class 4 gives an improved impression of reality in professional kitchens compared to climate class 3. Therefore, we will in Denmark also take a starting point in climate class 4 which is regarded as fair as kitchen environments often are somewhat warmer than normal room temperature.

Temperature class M1 and L1

EN441 deals with different climate classes as well as with different temperature classes. For instance, temperature class M1 indicates that the highest temperature of the warmest test package during testing always is less than (or equal to) +5°C and the lowest temperature of the coldest test package is always higher than (or equal to) –1°C.

Temperature class L1 indicates that the warmest package always is below (or equal to) – 15°C and the lowest temperature of the warmest test package is less than (or equal to) – 18°C.

Other temperature classes also exist, but they will not be mentioned here as that would create unnecessary confusion.

Climate chamber

The energy test takes place in a climate chamber according to the specifications in EN441. That i.a. means that the climate chamber has to be insulated, the floor must be made of concrete, the luminous intensity has to be 600 (+-100) lux, walls and doors have to be painted light grey with an emissivity of between 0.9 and 1.0. There has to be a horizontal air velocity of between 0.1 and 0.2 m/sec. Air temperatures measured at different heights must not deviate more than 2°C from the specified climate temperature and the relative humidity must not vary more than 3 percentage point. For further details please refer to the standard.

Test packages

During testing it is necessary to use test packages and M-packages similar to the packages used to test domestic refrigerators and freezers. Packages with a specified content consisting of water and some artificial substances are in question. The packages are wrapped in clear plastic film. The thermal properties correspond more or less to minced meat and the content looks like marzipan. Different sizes exist: 1 kg, 0.5 kg 0.125 kg. The 1 kg packages more or less have the same shape as a brick (50 * 100 * 200 mm).

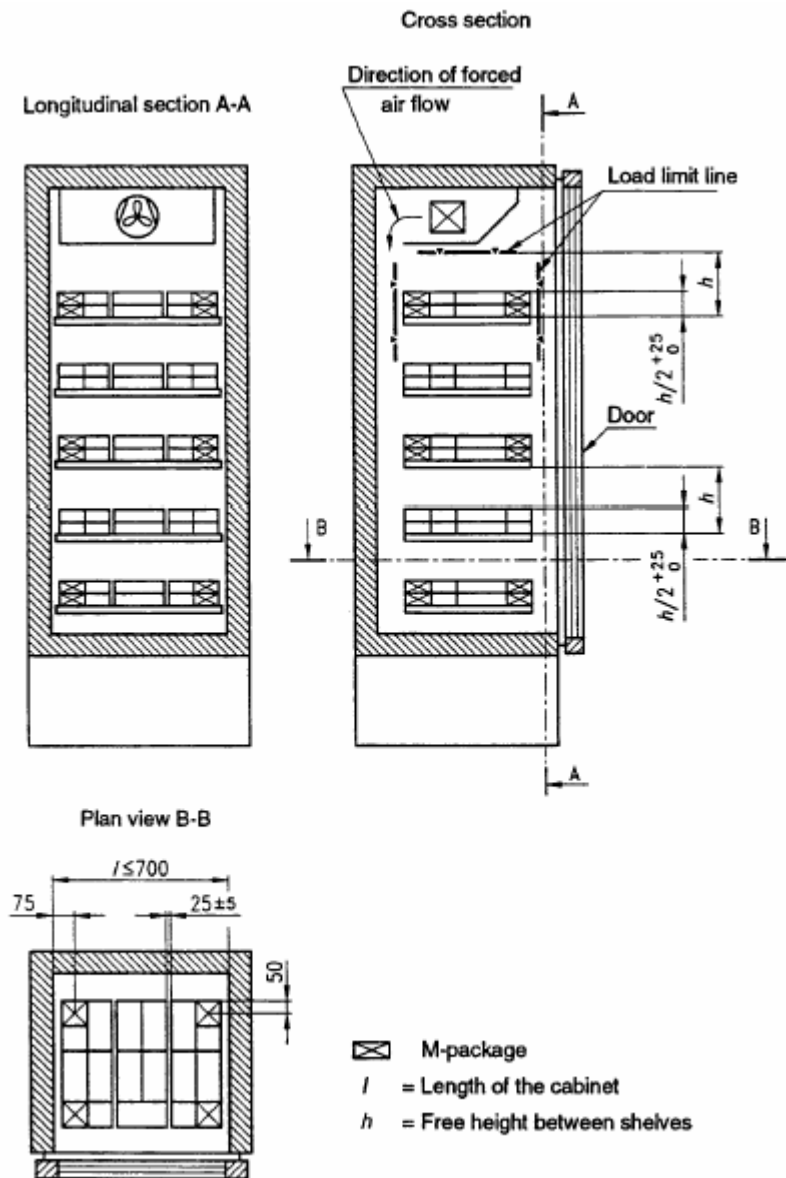
M-packages have specific locations and the packages are similar to the 0.5 kg test packages (50 * 100 * 100 mm). In addition, a thermocouple is placed in the middle with a wire for data collection.

The test and M-packages are used for all temperature classes.

A large amount of work is involved in maintaining and calibrating test and M-packages as the packages tend to lose shape and have to be re-frozen into the right shape after thawing.

Packing plan

EN441 specifies, how the cabinet should be packed with packages. Packing has to take place according to figure 10 in EN441-5 (Closed vertical cabinet).



Dimensions in mm

The figure (Figure 10 in EN441) shows how test packages and M-packages (with crosses) should be packed.

The filling height on the shelves must be half of the free height (with a margin between 0 and 25 mm). The M-packages have to be placed near the edges as shown in the above figure. For further details please refer to EN441 (part 5).

Door openings

Each door or glass lid has to be opened 6 times/hour. If there is more than one door or glass lid, the doors (or lids) have to be opened in shifts. If there e.g. are two doors, door 1 has to be opened at 0 minutes, door 2 at 5 minutes, door 1 is reopened at 10 minutes etc. The doors have to be opened up to an angle of more than 60° . The door has to remain open for 12 seconds, so it is open to air of more than 60° for at least 10 seconds.

The test has to take at least 48 hours and the doors have to be opened for a period of 12 hours followed by a period of 12 hours without any door openings. At the beginning of a door opening period, the door initially has to remain open for 3 minutes.

In practice, the door openings take place with a small, simple robot that is controlled by a PLC or the like.

One reason why door openings are necessary is to ensure that the cooling capacity of the cabinet is sufficient and to ensure that the defrosting function is tested, as door openings ensure that moisture enters the cabinet.

Evaporation of condensate

The appliance tested must be able to evaporate the water generated during the test period. The measurement of the energy consumption starts when there is equilibrium in the container, where evaporation of the water takes place. This means that there no more is an accumulation of water in that container (over a period of 24 hours). The water must not be brought out of the container to a drain.

Test period

The test starts with a running-in period during which all temperatures etc. are registered. Near the end of the running-in period the cabinet (including test packages) is in equilibrium. As indicated above, the test period itself has to take at least 48 hours and the starting and closing time have to correspond to each other on the time/temperature curve.

All temperatures are registered in the test and the following temperature curves have to be included in the test report:

- The temperature of the warmest test package, i.e. the temperature of the package with the warmest actual temperature (highest peak temperature).
- The temperature of the coldest test package, i.e. the temperature of the package with the coldest actual temperature.
- The arithmetic average temperature of all visible M-packages, i.e. the packages that are placed near the door.
- The arithmetic average temperature of all M-packages.

The temperatures have to be registered at least once/minute.

Test report

The test report (as described in EN441) shall include the following:

- a) The manufacturer's name and/or the commodity name
- b) The cabinet's model name and serial number
- c) Climate class of the test
- d) Method used for temperature control, defrosting process, end of defrosting, adjustment parameters and sensor position
- e) Time/temperature curves of the coldest and warmest M-package as stated above and extreme values
- f) Average temperature of all M-packages

- g) If the temperature can be read on the cabinet: sensor position and maximum value during equilibrium conditions and just after defrosting.

In addition, the electricity consumption has to be registered. During the test all electricity consuming components and systems in the cabinet have to be connected which normally also is the case. Electricity consumption TEC = Total Energy Consumption must be stated in the report (according to EN441) in kWh/24 h.

At this stage it should be noted that the test in general is quite demanding. The rather high ambient temperature and the many door openings result in a relatively large energy consumption for professional kitchen cabinets. Therefore, a relatively large energy consumption will appear from the test reports and that is especially the case for freezers.

Relative energy consumption

A relative energy consumption, e.g. kWh/m³ net volume/48 hours or the like, is used in energy labelling schemes.

In the British scheme for the positive list for energy efficient professional kitchen cabinets the above relative energy consumption is used.

In order to calculate the relative energy consumption it is necessary to use the energy consumption from the test report (energy consumption during 48 hours!) and the net volume of the cabinet.

A separate note will be prepared of the measuring of the net volume according to EN441.