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Version 8, 14 December 2018

EEPLIANT2 Work Package 6 – Professional Refrigeration

Protocol for consistent interpretation of EN16825:2016 for the EEPLIANT2 testing programme

Version 8, 14 December 2018

This protocol is intended for use within the EEPLIANT2 Joint Action and does not necessarily reflect the enforcement approach of any MSA. This protocol does not constrain in any way the scope for an MSA to interpret test results or interpret the test process as they see fit in particular circumstances. The results from carrying out this protocol under the EEPLIANT2 Joint Action may be used to help inform future development of the test standard and regulations.

This protocol is not intended to *alter* any instructions given in EN 16825: 2016 or the relevant regulations, but only to ensure that a consistent and uniform methodology is followed by test labs under the EEPLIANT2 Joint Action, which is agreed as appropriate by EEPLIANT2 participants and, as far as possible, with the support of wider stakeholders.

INFORMATION TO BE REQUESTED FROM SUPPLIER BEFORE THE TEST

The following information will be requested from suppliers by MSAs to ensure that testing is carried out in a repeatable and reproducible way and, only where the terms of the standard are not sufficiently specific, to replicate the conditions in which the declared performance was achieved by suppliers:

1. If the cabinet has control settings other than storage temperature and the user manual is not sufficiently clear about the settings to be used: the control settings used to achieve the declared energy performance figures.
2. Testing will be carried out with the minimum number of shelves as prescribed in EN 16825 §5.3.3.3.2 b). If the cabinet is shipped with less shelves than this, please provide any additional shelves required to meet this minimum number.
3. As it may be necessary for thermocouple cables to be routed through a cabinet wall or through the structure of the door, please provide any relevant advice about where a hole should be drilled with minimum structural damage and to avoid electrics etc. Note: any hole will be back-filled with thermal filler around the wires and sealed before testing begins.
4. If no upper load limit line is marked inside the cabinet, please provide a description and measurement of where this is intended to be positioned.

CABINET SET UP

5. Prosafe will endeavour to provide any information provided by the supplier as in the preceding section that can be taken into account by MSAs and test labs when testing cabinet(s) for compliance. If this information is not made available, in addition to following the standard and regulations, the test lab will select control settings based on information in the owner's manual and its own staff professional judgement. Details

of temperature and any relevant control settings and position of shelves used are to be carefully noted in the reports, including photographs where helpful.

6. Cabinets will be tested as supplied ('out of the box') without modification other than set up as required by the test standard and the regulations, and as interpreted by this protocol where applicable.
7. The distance between cabinet and rear wall behind the cabinet will be set as per the instruction manual or by using any stand-offs provided for that purpose. In the absence of both of these, the cabinet will be placed **flush against the test chamber panel.**
8. Multi-use compartments (those that can be used at frozen or chilled temperature according to a user setting), must be tested at frozen temperature (in line with Ecodesign Regulation Annex IV, 2., c)).
9. Routing of thermocouple / sensor cables: In order to avoid warm air and moisture ingress, thermocouple cables are to be routed through a small hole drilled in the cabinet side or rear wall or in the door. Drill a hole at a location in line with advice from the supplier and in any case avoiding as far as possible structural and functional features. The hole should be minimally sized to comfortably accept all thermocouple cables; carefully fill gaps around the cables with a suitable sealant to minimise air ingress and heat transfer (see Figure 1).

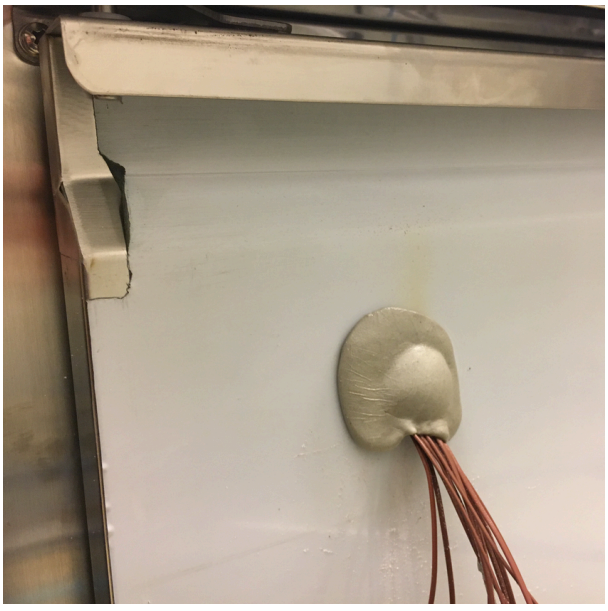

Figure 1. An example set up with hole for thermocouple cables drilled near the hinge side of the door, near the top of the door and with the hole carefully blocked with putty to prevent passage of air and moisture.

TEST PROCESS AND MEASUREMENTS TO BE CARRIED OUT

10. The following parameters will be measured according to the standard in a fully compliant test room:
    a) Calculation of net volume (EN 16825:2016 §6.1). If any points of ambiguity arise in how volume is calculated then the decisions taken must be noted in the test report (see section below on calculation of storage volume and load limit line);

b) Temperature test: at climate class 4 for standard duty and heavy duty cabinets; light duty cabinets to be tested at climate class 3 (EN 16825:2016 §5.3.4).

c) If the cabinet is declared as light duty cabinet, the lab is invited to state a view in a separate supplementary report (not in the formal test report) as to whether the cabinet's physical features and components are consistent with that classification, because, as per Regulation 2015/1094 Annex I §9, *"if the cabinet is able to maintain temperature in ambient conditions corresponding to climate class 4, it shall not be considered a light-duty cabinet"*. Such cabinets may be tested at climate class 3 and at climate class 4 – this option should be discussed between the MSA, test lab and PROSAFE.

d) Additional temperature test for heavy duty cabinets at climate class 5 to confirm qualification as 'heavy duty' (EN 16825:2016 §5.3.4). The heavy-duty temperature test requires door/drawer openings and the temperatures of the packages shall stay within the required limits, but the measurement of energy consumption is not required;

e) Electrical energy consumption: at climate class 4 for standard duty and for heavy duty cabinets; light duty cabinets at climate class 3 with calculated adjustment as per regulations (EN 16825:2016 §5.3.6);

f) Calculations of EEI and AEC (1094/2015 and 1095/2015).

11. Testing will follow the testing cycle as set out in EN16825 §5.3.3.6.1, being the stabilisation period (§5.3.3.5 *Stable conditions*) plus 2x24 hr combined energy & temperature test periods (§5.3.6 *Electrical energy consumption test*). During the first 24 h-period the temperature and energy data shall be measured but shall not be included in the calculation of the cabinet energy consumption. During the second 24 h-period the temperature and energy data shall be measured and shall be included in the calculation of the cabinet energy consumption.

STORAGE TEMPERATURES TO BE ACHIEVED

12. The aim during the combined temperature and energy consumption test cycles under the EEPLIANT2 Joint Action is that the cabinet should meet the temperature requirements of its temperature class (EN 16825: 2016 Table 1) but that the temperatures used in the test are no lower than they have to be to achieve that. This is because more energy is used to achieve a lower temperature. For these tests, the aim is that the highest temperature of the warmest M-pack is within the following tolerance of the maximum limit: 1K for class L1, i.e. >=-16°C; 0.5K for class M1, i.e. >=+4.5°C[1]. More than one test cycle may be needed to achieve this with thermostat adjustments, unless any other reason for curtailing the test as set out below applies. Note: Table 1 also requires that for class L1, the warmest M-pack dips below -18°C during the test.

13. If a cabinet cannot attain the maximum temperature requirement after its first test cycle, then the test is repeated with a lower thermostat setting. If the cabinet cannot be shown to meet the maximum temperature requirement after a test cycle at the

[1] The difference in tolerance between frozen and chilled is to achieve approximately equal influence on the impact a measurement taken at the tolerance limit makes to energy consumption: in both cases around 2% (based on refrigeration rules of thumb for energy consumption with respect to Delta-T).

lowest thermostat setting that can be set by the user (and according to the instruction manual)[2], then the energy test is deemed invalid and the cabinet FAILS - all results are to be kept for information purposes.

14. **IF**, after the first test cycle, the cabinet:

    i. FAILS the maximum energy consumption (ecodesign) requirement when the verification tolerances are applied, as set out in regulation 2015/1095, as amended by 2016/2282 Annex IX (being "*The determined value shall not exceed the declared value by more than 10 %*")
    OR

    ii. FAILS to match its declared energy consumption figure (kWh/annum) when the verification tolerances are applied, as set out in regulation 2015/1094, as amended by 2017/254 Annex XIII (being *"The determined value shall not exceed the declared value by more than 10 %"*). Achieving a figure lower than the declared figure counts as a PASS.
    AND

    iii. The highest temperature of the warmest M-pack was not within 1K of the maximum threshold for L1 and within 0.5K of the maximum threshold for M1

    THEN the cycle must be repeated with a control setting adjusted with the aim to bring the highest temperature of the warmest M-pack within 1K (frozen) or 0.5K (chilled) of the threshold. If during a second test, the highest temperature of the warmest M-pack is not closer than 2K to the threshold for L1 or 1K for M1, then it must be repeated a third time to bring it closer. If the second test achieves closer than 2K for L1 or 1K for M1 then no further test is required. No more than three test cycles are required, even if the warmest M-pack is still not within the threshold 2K for L1 or 1K for M1 with different settings, as long as best efforts were made to achieve the target and all results are recorded and kept for subsequent interpolation / extrapolation analysis if this is deemed necessary by Prosafe.
    Note: interpolation is more precise if results at no more than 4K above and no more than 4K below target are recorded[3]. If the difference between the widest two measurements is less than 3K then the accuracy of extrapolation or interpolation is much reduced (see calculation method below).

INDICATIVE PASS AND FAIL FOR ENERGY MEASUREMENTS

15. If a result **passes** the maximum energy consumption (ecodesign) requirement and matches the declared energy consumption figure (or less) whilst at a **lower** storage temperature than required (whilst remaining within the required range in the case of a chilled cabinet), then it can be deemed to PASS at the required temperature and no further energy testing is necessary.

[2] It can also be assumed that no lower temperature can be achieved if the compressor is running for 100% of the time (outside of defrosts).
[3] This principle is explained in IEC 62552 part 3 Annex I Worked examples of energy consumption calculations, section I.3.2.2 Single compartment example.

16. Considering the result closest to intended conditions after a maximum of three test cycles, if the cabinet **fails** any of the energy requirements after following this procedure then the cabinet can be deemed to FAIL compliance.
17. The MSA is invited to consider discretion regarding enforcement action if the tolerances suggested for using the highest practicable storage temperature were not met in the test (i.e. a highest M-pack temperature which is lower than that required by more than 1K (frozen) or 0.5K (chilled)): in this case, the three different results can be used to extrapolate a result[4] as if the temperature attained was exactly at the required storage temperature, using the methodology of IEC 62552: 2015, part 3, Annex I *Worked examples of energy consumption calculations*, section *I.3.2.2 Single compartment example*. If the difference between the two widest measurements is less than 3K then the accuracy of extrapolation or interpolation is much reduced and the following rule of thumb can be applied instead: 2% per degree K for chilled cabinets and 4% per degree K for freezer cabinets[5]. The extrapolated figure can be compared with the requirement thresholds to give an *indicative* compliance result, bearing in mind that this is not an approach permitted by the Regulation nor the standard but could be discussed with the supplier. The extrapolation calculation is not to be inserted into the standard test report but must be reported separately (as it is not part of the standard test).
18. If a cabinet **fails** any of the energy requirements whilst at a **higher** storage temperature than required, then it can be deemed to FAIL at the required temperature and no further energy testing is necessary, but all results must be kept. If it is a heavy-duty cabinet then the Climate Class 5 temperature test must still be carried out (for information to MSAs).
19. Measured energy consumption is assessed against the declared energy consumption, applying the verification tolerance as set out in regulation 2015/1094, as amended by 2017/254 Annex XIII (being *"The determined value shall not exceed the declared value by more than 10 %"*).
20. Measured internal volume is assessed against the declared internal volume, applying the verification tolerance (same source, *"the determined value shall not be lower than the declared value by more than 3 %"*) to determine if the declared values PASS or FAIL.
21. The lab shall check that the values of energy consumption and internal volume as declared by the supplier lead to the declared energy label by means of the relevant formula and Table in the Regulation, taking into account the relevant verification tolerances.
    Note: The *measured* energy consumption and *measured* volume are not combined to derive an energy label class to compare with that declared.

MEASUREMENT OF VOLUME AND LOAD LIMIT LINES

22. **Some cabinets with more than one door have an open volume between the door pillar and the rear of the compartment, which is between the two halves of a single**

[4] It is recognised that interpolation is statistically more accurate (over a limited range) and is the preferred route if the data makes it possible. It is more likely that extrapolation will be necessary here. More research would be needed to verify the accuracy of extrapolation.
[5] The figures of 2% and 4% are mid-points of the range of percentage increases in energy consumption per degree K set out in IEC 62552: 2016 Annex I, §I.4.1 (which quotes "1% to 3%" and "2% to 5%").

compartment that the two doors open into, as in Figure 2. Since volume is calculated based on the shelf area, this volume is not usually included. However, some manufacturers supply pieces of 'bridging' shelving to place between the two compartments, so that items can be stacked within this volume behind the door post. If bridging shelving is provided by the manufacturer, then for the purposes of EEPLIANT2 test reports, TWO volumes are to be calculated and reported: one with the bridging volume included, and a second using only the standard shelf areas. Other calculations that depend on the volume are to be calculated with both volume options and clearly labelled as to which is which. MSAs will decide which volume to take into account.

Figure 2. Two door cabinet with volume behind the door post and gap between the two halves of the single compartment.

23. A load limit line marking is required to be marked on the cabinet liner unless particular cabinet design circumstances apply (EN 16825: 2016, §8.1). The load limit line is at the top of the compartment and is used for the calculation of internal volume and for determination of the loading level for the temperature and energy test (cabinet is loaded to half way between top shelf and loading line). Anecdotal evidence suggests that load lines are rarely seen in cabinets, however, EN 16825 does not address the situation where there is no load line marked.
24. If there is no load line then firstly, the instruction manual should be consulted for guidance about loading; if no guidance is given then the following assumptions apply:
    a) If there is no vent or duct at the top of the compartment, then the **load line is assumed to be at the height of the top of the inner liner of the compartment or at the height of the upper face of the door aperture, whichever is lower**;

b) If there is a vent or duct outlet at the top of the compartment, then the load line is assumed to be **10mm**[6] below the lower edge of the vent or duct outlet **or at the height of the upper face of the door aperture, whichever is lower**.

c) **In the absence of a load line, any refrigerated volume at the top of a compartment that lies above the horizontal plane that includes the upper face of the door aperture is not to be included in the volume calculation. This is on the practical basis that this volume cannot be accessed by sliding a container into the compartment. If the load line is within that volume, then this fact must be clearly flagged in the test report and the load line is used as the basis for volume calculation.**

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[6] EN62552 for household refrigerators, §6.3.3.3.3 defines "Top clearance". This specifies in the case of no load limit then the gap above the top face of the package shall be "10 mm ≤ clearance < 60 mm". This is taken as an indicative appropriate gap to allow.

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Explanatory notes on why the proposed process and tolerances on temperature attainment were adopted:

i. A practical cap on the number of repeat tests to be carried out on any given cabinet is adopted in order to balance the need to determine results that fairly reflect the performance of the cabinet with the need to make best use of the available funds under the EEPLIANT2 Joint Action, through testing as many different cabinets as possible with the available funds.

ii. The regulation requires that: "*The temperature of test packages shall be between - 1 °C and 5 °C for chilled cabinets and lower than -15 °C for frozen cabinets*" (Ecodesign Regulation Annex IV, 2., a)).

iii. The highest temperature of the warmest M-pack must stay below the required upper limits (5ºC and -15ºC); for chilled cabinets the lowest temperature of the coldest M-pack must stay above the lower limit (-1ºC). (Note: in addition, the lowest temperature of the warmest M-package must be <= -18°C for freezer cabinets).

iv. Laws of thermodynamics assure that the warmer the storage temperature, the lower the energy consumption; manufacturers may decide to use a thermostat setting that ensures temperatures are as warm as permitted for their declarations in order to use the minimum energy. Manufacturers may decide to appeal if lower temperatures than necessary are used for assessment.

v. If the lab was to try and find the exact thermostat setting that achieves a highest temperature of the warmest M-pack of exactly -15ºC, this could mean repeating a stabilisation and 2x24 hr testing cycle many times which could become prohibitively expensive. In particular, digital thermostats with discrete steps in their settings (often whole degrees) do not allow fine adjustment anyway.

vi. Attainment (or not) of the temperature limits is not known for sure until completion of the full test cycle (although a wildly low or high result can be spotted earlier and the test stopped and new setting tried).

vii. Whilst the test lab is repeating tests to find the best setting, results from all exploratory test cycles can be kept and analysed - then extrapolation or interpolation can be used as the basis for a discussion with suppliers about likelihood of compliance at the precise temperature, even if that temperature is not achieved under test.

Note: An energy result for the precise storage temperature is calculated under the IEC 62552: 2015 household refrigerator test through interpolation of test results: using one test slightly above the limit and a second test slightly below the limit. This approach is not described in EN16825 but should be considered for a future update if this pragmatic approach can be shown as appropriate for professional refrigerators.