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Working Party on the Transport of Perishable Foodstuffs
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AGREEMENT ON THE INTERNATIONAL CARRIAGE OF PERISHABLE FOODSTUFFS AND ON THE SPECIAL EQUIPMENT TO BE USED (ATP)

Proposed amendment to Annex 1, Appendix 2
Test and approval for multi-compartment and multi-temperature equipments

Transmitted by Germany

1. Reasons

New draft of the test procedure

This new test procedure is more effective for the user and the costs for the test procedure are less than the provisional test procedure. For equipment in service, measurement results can be compared with the set values of the type test.

Components of the proposal are:

- The refrigerating units shall be tested only with separated insulated boxes, because the accuracy of testing with separated boxes is more precise than testing with a multi compartment vehicle. Also the test in separated insulated boxes is more economically.
- The tests of the "useful cooling capacity" (factor U and V for the test) is not useful for the cooling capacity in praxis.
- It is necessary to have a test procedure for the determination of the heating capacity for the mechanically refrigerating unit. This is necessary for the user and the certification (one sample from the praxis: outside temperature –10°C, one compartment –30°C and one compartment 0°C. So it is necessary to heat this compartment).

- It is necessary to have a test procedure for the function test "defrost". This is very important, if one evaporator is in heating mode and the another evaporator is in cooling mode.
- It is necessary to have a test procedure for the determination of the air flow (Wurfeite) of each evaporator. In a vehicle with longitudinal walls the compartments are very long and small. The compartments are very small and it is necessary to have a good air-changing in the whole compartment.

The results of the tested units according to the provisional test procedure are mostly comparable or can be calculated with the results of the type test according this new test procedure.

2. Proposal

Annex 1, Appendix 2: supplementing of the paragraphs 61 until 68

E. Test procedures, test report and certification for multi-compartment and multi-temperature equipment's

(61) Definitions

Multi-compartment equipment: Insulated equipment with two or more compartments.

Multi-temperature equipment: Insulated equipment with two or more compartments for different temperatures in each compartment.

Multi-temperature refrigeration unit: Cooling or heating (thermal) appliances for a multi-temperature equipment

Multi-temperature mechanical refrigeration unit: Cooling or heating (thermal) appliances with compressor (one condensing unit with one ore more evaporator units or one condensing unit with one evaporator unit and one or more fans (air duct systems) for the different compartments) for a multi-temperature equipment.

Nominal cooling capacity: Cooling capacity of the complete refrigeration unit or of the condensing unit with one or more separated evaporator units.

Useful cooling capacity: Cooling capacity of each possible evaporator unit in conjunction with the condensing unit operating and the other evaporator units are operating in different conditions or the complete refrigeration unit is in operation with the fans (air duct system) by different conditions in the compartments.

Nominal heating capacity: Heating capacity of the complete refrigeration unit or the condensing unit with one or more separated evaporator units which have a maximum surface operating at the same temperature.

Useful heating capacity: Heating capacity of each possible evaporator unit in conjunction with the condensing unit operating and the other evaporator units are operating in different conditions

(62) Test procedure for multi-compartment and multi-temperature equipment with thermal appliances.

The tests can be carried out :

a) Combined testing

On the complete insulated equipment equipped (as the case may be) with one or several thermal appliances.
After measuring the insulating capacity of the insulated equipment (K-coefficient) according to the procedure in paragraphs 7 to 27 and 30 a check of the efficiency of the thermal appliances as described in paragraphs 31 of this appendix has to follow.

The distribution system of pipes and cables which pass through insulated walls must be insulated so as to limit the losses through the thermal bridges caused by the installation.

b) Separated testing

If the multi-temperature refrigeration unit is to test separately the insulated equipment, then the insulating capacity of the insulated equipment (k coefficient) is measured as described in 7 to 27 and 30 of this appendix.
When installing the multi-temperature unit on the insulated equipment (according to the procedure described in paragraph 2 (c) (iii) (b) of Annex 1, Appendix 1 of ATP) the distribution system of pipes and cables which pass through insulated walls must be insulated so as to limit the losses through the thermal bridges caused by the installation.

(63) Capacity

The nominal and the useful capacities of the multi-temperature refrigeration unit shall be measured according to the procedures described in paragraph 66 or 67 of this appendix.
When installing the multi-temperature refrigeration unit on the insulated equipment the distribution system of pipes and cables which pass through insulated walls must be insulated so as to limit the losses through the thermal bridges caused by the installation.

(64) K coefficient.

The overall K coefficient of the complete multi-temperature / multi-compartment equipment must be measured as in the procedures described in paragraphs 1 to 15 for the equipment with movable bulkheads, and paragraphs 1 to 15 plus 20 and 21 (b) for equipment with fixed bulkheads.

(65) Bulkheads

For multi-temperature or multi-compartment equipment, internal bulkheads which separate compartments shall be treated as follows:

Bulkhead type	Minimum insulation thickness	Assumed K-coefficient
Fixed transverse	40 mm	1.0 W/m²K
Movable transverse	40 mm	2.0 W/m²K
Fixed longitudinal	25 mm	1.5 W/m²K
Movable longitudinal	25 mm	2.5 W/m²K

It is also assumed that manufacturers of these internal bulkheads will use the most effective insulation material available, as they would use to insulate the external side-walls of the equipment. Use of inferior insulation material in the construction of internal bulkheads will disqualify the manufacturer from using the above facility. Under such circumstances the competent authorities will have to test a complete vehicle according to the provisions described in paragraph 62.

Note: The above figures have been introduced to facilitate the necessary calculations required to match evaporator cooling capacities to the maximum thermal losses of each compartment. They are an assumption and must not be used as a rule to correlate the K-coefficient against insulation thickness.

(66) Procedure for testing of multi-temperature mechanically refrigerated units.

Testing may be carried out on a complete equipment or by using the appropriate number of calorimeters.

The tests must be carried out on a complete operating multi-temperature unit with two or three evaporators.

The tests to determine the K-coefficient of the complete equipment or the calorimeters and the capacity must be according to the provisions described in the paragraphs 51 to 59. The heating capacity shall be determined with an accuracy of ? 10 %.

The following series of tests shall be completed:

1) The nominal cooling capacity of the compact unit or the condensing unit equipped with two or more evaporator units. The air temperatures at the inlet to the condensing unit shall be controlled at 30 °C ? 0.5 K for all testing points.
The test conditions of the nominal cooling capacities are 30 °C / -20 °C or 30 °C / -30 °C and 30 °C / 0 °C and 30 °C / 12 °C and maintained at the temperature by addition of heat balance which is measured and recorded.
Interpolation will provide 30 °C / -10 °C and if it applies 30 °C / -20 °C.

2) The tests for the useful cooling capacity must be carried out on a compact unit or a complete operating multi-temperature refrigeration unit with two or more evaporator units. The air temperatures at the inlet to the condensing unit shall be controlled at 30 °C ? 0.5 K for all testing points.
The internal temperatures of each compartment shall be reduced to 12 °C. The internal temperature of one compartment shall be further reduced to -20 °C or -30 °C and maintained at the temperature by the addition of a balance heat which is measured and recorded. At the same time a heat load equal to 40 % of the nominal cooling capacity of the multi-temperature unit at -20 °C or -30 °C is added to the compartment which are controlled at 12 °C. In case of three compartments the heat load for each compartment is 20 %.
The above process is repeated for each type of evaporator unit / compartment in the multi-temperature unit on test.

3) The nominal heating capacities of a compact unit or the condensing unit equipped with two or more evaporator units for a maximum operating surface shall be measured. The air temperature at the inlet to the condensing unit shall be controlled at -10 °C ? 0,5 K for all testing points.
The test conditions of the nominal heating capacities are -10 °C / 12 °C and -10 °C / 0°C and maintained at the temperature by addition of cooling balance which is measured and recorded.

4) The test for the useful heating capacity must be carried out on a compact unit or complete operating multi-temperature unit with two or more evaporators. The air temperature at the inlet to the condensing unit shall be controlled at -10 °C ? 0.5 K.
The internal temperature of the compartment with the smallest capacity evaporator unit which is determined with the test of point 3 shall be reduced to -20 °C and maintained at the temperature by the addition of heat balance which is measured and recorded. The temperature of the other compartments are heated to 12 °C and maintained at the temperature by the addition of cooling balance which is measured and recorded.

5) Evaporator airflow

Each alternative evaporator's fan delivery volume and mean airspeed will be measured using an internationally recognised method (such as BS 848, ANSI/AMCA 210-85 etc.).

6) Test report

A test report (Model 11) shall be completed to include the results of the above testing of the multi-temperature unit.

7) Certification

Using the test report (Model 11), calculations shall be made to ensure that the measured nominal capacity of all installed evaporator units is at least 2.25 times the thermal losses through the sidewalls, floor, front bulkhead, roof and doors of the vehicle.
The useful capacity of each evaporator must be at least 2.25 times the calculated thermal losses through the sidewalls, floor, bulkheads/doors and roof of the compartment in which the evaporator operates. The thermal losses of the internal bulkheads have to be calculated with maximum temperature differences of 30 K at 0°C, 50 K at –20°C and respectively 60 K at –30°C.

The measured air volume in m^3/h of the evaporator unit divided by the maximum air volume of the compartment in which the evaporator unit operates must be at least 60 (air changes per hour).
The ATP certificate can be issued for the multi-temperature units / multi-temperature equipment according annex 1, appendix 3, model B.

(67) Procedure for testing of multi-temperature systems where cold air is blown by fans from the low temperature compartment to control the temperature in the second compartment at higher temperature.

This procedure for testing includes all fan driven air duct systems like roof mounted or bulkhead fan systems to control the higher temperature in a second compartment by controlled air exchange with the low temperature compartment that is cooled by a mechanical refrigeration unit.

Nominal refrigeration Capacity

The nominal refrigeration capacity of the compact refrigeration unit has to be measured at 30 °C / -20 °C or 30 °C / -30 °C, 30 °C / 0 °C and 30 °C / 12 °C, according to the paragraphs 51 to 59. Interpolation will provide 30 °C / -10 °C and if it applies 30 °C / -20 °C.

Useful refrigeration capacity

Testing may be carried out on a complete equipment.

1) Testing on a complete vehicle of the useful cooling capacity

The movable bulkhead is positioned in place to maximise the size of the higher temperature compartment.
For the testing of the useful cooling capacity the mechanical refrigeration unit is then operated at 30 °C / -20 °C or 30 °C / -30 °C conditions and the fans of the air duct system are operated continuously at 12 °C.
A heat balance heat is added at each compartment to maintain constant ~~the~~ temperatures.

2) Calculation of the useful cooling capacity

Based on the test results of the nominal cooling capacity of the mechanical refrigeration unit and the delivery volume of the air duct system fan the maximum useful cooling capacity of the air duct system in the higher temperature compartment can be calculated by the product of the delivery air volume of the air duct system fans with the enthalpy difference of the air at the inlet temperature of -20°C and the outlet temperature of 0°C respectively 12°C.

Airflow

The fan delivery volumes and airspeeds of the air duct system shall be measured.

Test Report

A test report (Model 12) shall be produced from the test results.

Certification

Based on the test report the calculations must show that the capacity of the complete refrigeration unit is at least 2,25 times the thermal losses through the floor, roof, sidewalls, front bulkhead and rear doors of the complete vehicle.
For the high temperature compartment at its maximum size the maximum cooling capacity due to the fans of the air duct system in this compartment has at least to be 2.25 times higher than its thermal losses. The thermal losses of the internal bulkheads have to be calculated with maximum temperature differences of 30 K at 0°C and 50 K at +12°C.
The thermal losses of internal bulkheads shall be treated as shown in paragraph 64 in this appendix.
The ATP certificate can be issued for the multi temperature/multi compartment vehicle according annex 1, appendix 3, model B.

(68) Control of the operation of a complete new multi-compartment / multi-temperature equipment

This test shall be carried out on site by the competent authority.
Its objective is to check that the multi-temperature unit controls the temperature set-point to within a tolerance within +/- 1.0 K each compartment
For example, at the following temperature for the equipment with three temperature-controlled compartments:

-20/-20/-20°C	0/12/-20°C	12/-20/0°C or
-30/-30/-30°C	0/12/-30°C	12/-30/0°C or

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