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Working Party on the Transport of Perishable Foodstuffs

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Item 5 (b) of the provisional agenda

PROPOSALS OF AMENDMENTS TO THE ATP

Pending issues

Proposal for an ATP Test Procedure for Multi-Temperature Vehicles
with Fan-Driven Air Distribution Systems

Transmitted by Transfrigoroute International (TI)

Note by the secretariat

The Programme of Work for 2006-2010 of the Inland Transport Committee adopted at its 68th session in 2006 (ECE/TRANS/166/Add.1, Item 2.11 (i)) requires the Working Party on the Transport of Perishable Foodstuffs (WP.11) to ensure the Harmonization of regulations and standards relating to the international transport of perishable foodstuffs and facilitation of its operations, *inter alia*, by the Consideration of amendment proposals relating to test methods and procedures for the approval of multi-compartment and multi-temperature vehicles, to take account of technical developments. The present document is submitted in conformity with that mandate.

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Introduction

1. This proposal is based on the former WP.11 papers TRANS/WP.11/1998/4, TRANS/WP.11/2000/1 and the Cambridge Refrigeration Technology (CRT) paper dated 16/03/1999. It was discussed with the ATP test stations concerned, both the refrigeration machine and body builder industry and was agreed upon by the Transfrigoroute International Working Group on the ATP. The test procedure is in agreement with the ATP proposal for multi-temperature systems with several remote evaporators.

2. In addition to the tests for remote evaporators, the procedure proposed herewith is necessary to test the performance of the different fan systems on the market. In multi-temperature vehicles special bulkhead and roof-mounted fan systems are used to cool the chilled compartments by controlled air exchange with the deep frozen compartment which itself is cooled by a mechanical refrigeration unit.

3. Bulkhead fan systems are mainly installed in smaller rigids and trailers. Roof-mounted fan systems can also be fitted in larger rigids and semi trailers. Both systems are equipped with air flaps, which open and close automatically. In cooling mode air from the chilled compartment is blown via an automatically opening and closing flap into the deep frozen compartment, and cold air from the deep frozen compartment returns via another automatically opening and closing air return flap to the chilled compartment. Present air distribution systems are equipped with electrical heaters. In heating and in neutral mode both flaps to the deep frozen compartment close tightly automatically. For the provision of a uniform temperature distribution in the chilled compartment the fans run continuously in cooling, heating and neutral mode.

4. The temperature in the chilled compartment is controlled by a thermostat. In addition, a second thermostat is installed in the deep frozen compartment in order to assure that the thermal heat transmission to the chilled compartment is compensated by the mechanical refrigeration unit. Only when the required temperature of -20°C is reached in the deep frozen compartment is the cooling mode of the fan system activated by the second thermostat. Otherwise it is blocked.

5. The main advantages of these air distribution fan systems are the technical simplicity and reliability, the energy efficiency compared to multi-evaporator systems, and the very high cooling capacity. In multi-temperature operation, air distribution systems with powerful fans far exceed the cooling capacity of remote evaporators. Therefore the running time of the air distribution fan systems in cooling mode is only 2 to max. 5%. The performance and the accuracy of temperature control of multi-temperature refrigeration machines with fan systems are at the same level as those of units with remote evaporators.

6. Air distribution systems without air flaps and without automatic control are excluded from this proposed ATP test procedure. According to EU hygiene regulations the application of fan systems is limited to the transport of packaged foodstuffs or products not sensitive to odours.

IV. Test procedure for multi-temperature mechanical refrigeration units with fan systems for the distribution of cold air in chilled compartments

70. This procedure includes all fan-driven air distribution systems with self-operating air flaps like roof mounted or bulkhead fan systems to control the temperature in the chilled compartment by air exchange with the deep frozen compartment that is cooled by a mechanical refrigeration unit. Air distribution systems without or with no automatically controlled air flaps are excluded from this procedure.

71. Capacity tests of the mechanical refrigeration unit

If no test report is available, the nominal capacity of the host unit is measured at -20/+30°C and 0°C/+30°C conditions in mono-temperature operation according to paragraphs 51 to 59.

72. Air flow measurements of the fan system

The fan delivery volume V and air speed of the fan system shall be measured.

73. Test of the heating capacity of the fan system

The individual heating capacity of the fan system shall be measured by the determination of the electrical power input of the heaters and the motors of the fans.

74. Determination of the cooling capacity of the fan system

The maximum cooling capacity of the fan system can be calculated by the fan delivery volume V and the enthalpy difference   h of the air in the deep frozen and the chilled compartment. Depending on the operation time in cooling mode the cooling capacity W_{air} of the fan system is defined by

$$W_{air} = \text{relative runtime} * \frac{V * \quad h}{3.6}$$

V is the air volume in m^3/h delivered from the fan system to the chilled compartment at 0°C or +12°C,

  h is the enthalpy difference of the air (60% relative humidity) delivered to the chilled compartment for

-20°C/0°C   h = 41 kJ/m^3

-20°C/+12°C   h = 68 kJ/m^3

75. Determination of the remaining cooling capacity of the mechanical refrigeration unit in multi-temperature operation with the fan system

The useful cooling capacity of the host unit W remaining for the deep frozen compartment is equal to the difference of the nominal capacity of the host unit Wo in mono-temperature operation at +30/-20°C according to paragraph 71 and the required cooling capacity of the fan system unit W_{air} for the chilled compartment according to paragraph 74.

$$W = Wo - W_{air}$$

76. Certification

Based on the test report the calculations in paragraphs 74 and 75 must show that the cooling and/or the heating capacities of the complete multi-temperature mechanical refrigeration unit are at least 1.75 times higher than the thermal losses of the multi-compartment equipment determined according to paragraphs 68 and 69 for each compartment.

The fan system must be sufficient to maintain 0°C or +12°C in the chilled compartment with no more than 20% operational running time in cooling mode.

The cooling capacity and the delivering air volume of the mechanical refrigeration unit must be sufficient to maintain a temperature of -20°C within a variation of ±2 K in the deep frozen compartment. In addition the mechanical refrigeration unit must be equipped with control devices to ensure an average temperature of -20°C in the deep frozen compartment.

In addition the cooling capacities of the host unit in mono-temperature operation must be 1.75 times higher than the thermal losses through the floor, roof, sidewalls, front bulkhead and rear doors of the complete vehicle at +30/-20°C conditions.

With regard to hygiene regulations, fan systems can only be applied for transport of packaged foodstuffs and products not sensitive to odours.
