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Proposals of amendments to ATP: Pending proposals

Procedure for measuring the capacity of single temperature and multi-temperature liquefied gas units

Transmitted by the Government of France

Background

1. Most of the refrigeration units currently carrying perishable foodstuffs by road operate with the use of mechanical vapour compression.

2. Today, new refrigerating technologies based on an open thermodynamic cycle are emerging as an alternative to compression units. There are machines with “direct” injection and others with “indirect” injection through a ventilated exchanger. They use either liquid nitrogen (N_2) or liquid carbon dioxide (CO_2).

3. These units are clearly identified in the paragraph of ATP[1] on “Refrigerated equipment”. The test protocol is the same as for units with eutectic plates. This method is reliable and tested, but for a given type of unit it requires a large number of tests, owing to the number of bodies on which such units can be installed. There is no provision for individual testing of refrigeration units.

4. The lack of any test procedure for refrigeration-only units actually puts the technology at a disadvantage compared to competing technologies, despite the fact that it is a much awaited alternative for some applications.

[1] Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage.

5. Provisions should be included in ATP for measuring the refrigeration capacity of these units and for dimensioning the equipment that uses them, taking an approach similar to that for mechanical vapour compression units.

Proposal

6. This proposal introduces the testing methodology for liquefied gas refrigeration units of both mono-temperature and multi-temperature types.

7. The method applies to both “direct” and “indirect” units.

Principles of the test methodology for liquefied gas refrigeration units

8. The test methodology is derived directly from the one described in annex 1, appendix 2, section 8, paragraph 2, of ATP, entitled “PROCEDURE FOR MEASURING THE CAPACITY OF MECHANICAL MULTI-TEMPERATURE REFRIGERATION UNITS AND DIMENSIONING MULTI-COMPARTMENT EQUIPMENT”, in the version approved on 23 September 2013.

9. In a new paragraph, it introduces the adjustments that become necessary because of the specific features of the technique concerned:

- Specific definitions;
- Procedure for determining the individual refrigerating capacity of refrigeration evaporators of a liquefied gas refrigeration unit;
- Procedure for determining the maximum nominal refrigerating capacity of a liquefied gas refrigeration unit;
- Procedure for determining the remaining effective refrigerating capacity of a liquefied gas refrigeration unit in multi-temperature operation at a reference heat load.

Impact

10. This proposal would provide a methodology for measuring the refrigerating capacity of the new cold-producing technologies employed by liquefied-gas-based refrigeration units. The methodology is based on the existing methodology in ATP for mono-temperature and multi-temperature refrigeration units, which is tried and tested; it was finalized in 1998 and incorporated in the version of ATP approved on 23 September 2013.

11. The proposal requires an amendment to the Agreement in order for it to be fully and directly usable.

Environmental impact

12. This proposal would make it possible to considerably reduce the number of tests and thus their environmental impact. It would also avoid penalizing a credible alternative to the use of vapour-compression units that use high global warming potential (GWP) refrigerants, which are targeted by international protocols aimed at limiting the greenhouse gas effect.

Economic impact

13. The cost of testing these materials will be reduced considerably once they are introduced on a large range of insulated units. The cost for manufacturers and, in turn, their customers will be drastically reduced.

Proposed amendment to the Agreement

14. It is proposed that a new section 9 should be added to annex 1, appendix 2, of ATP, as follows:

"9. Procedures for measuring the capacity of liquefied gas mono-temperature and multi-temperature refrigeration units and dimensioning multi-compartment equipment

9.1 Definitions

(a) Multi-compartment equipment: equipment with two or more insulated compartments for maintaining a different temperature in each compartment;

(b) Refrigeration evaporator: any component of a liquefied gas refrigeration unit that absorbs thermal capacity;

(c) Multi-temperature liquefied gas refrigeration unit: liquefied gas refrigeration unit with two or more evaporators set at different temperatures in the various compartments of multi-compartment equipment;

(d) Multi-temperature operation: operation of a multi-temperature liquefied gas refrigeration unit with two or more evaporators operating at different temperatures in multi-compartment equipment;

(e) Maximum nominal refrigerating capacity: maximum refrigerating capacity set by the manufacturer of the liquefied gas refrigeration unit in terms of dimensioning;

(f) Installed nominal refrigerating capacity: maximum refrigerating capacity deliverable by a given configuration of the liquefied gas refrigeration unit within the limit of the maximum nominal refrigerating capacity;

(g) Individual refrigerating capacity ($P_{ind\text{-}evap}$): maximum refrigerating capacity of each evaporator in solo operation with the host unit;

(h) Effective refrigerating capacity ($P_{eff\text{-}frozen\text{-}evap}$): refrigerating capacity available to the lowest temperature evaporator when two or more evaporators are each operating in multi-temperature mode, as prescribed in paragraph 8.3.5.

9.2 Test procedure for multi-temperature refrigeration units

9.2.1 General procedure

The test procedure shall be as prescribed in annex 1, appendix 2, section 4, of ATP, taking account of the following particularities.

The tests shall be conducted for the different refrigeration evaporators. Each refrigeration evaporator shall be tested on a separate calorimeter, if applicable, and placed in a temperature-controlled test cell.

The maximum refrigeration capacity of the host unit in mono-temperature operation, as prescribed in paragraph 9.2.2, shall be measured in combination with two or three evaporators, including the smallest and largest.

For mono-temperature liquefied gas refrigeration units, only the maximum nominal refrigerating capacities shall be measured, as prescribed in paragraph 9.2.2.

The individual refrigerating capacity shall be measured for all refrigeration evaporators, each in mono-temperature operation with the host unit, as prescribed in paragraph 9.2.3.

The refrigerating capacity shall be determined with the most representative liquefied gas tank that can be used with the system. If the capacity of that tank does not allow a full test to be conducted without intermediate refilling, a tank of a larger capacity may be used if:

- The design (pressure regulator, outlet header, filler valve, shut-off valve, etc.) is the same as that of the most representative tank; and
- The tank is marketed with the liquefied gas refrigeration unit on ATP-classified transport equipment.

All the elements of the liquefied gas refrigeration unit shall be placed in a thermostatic enclosure at 30 ºC.

The test shall be conducted with two or three evaporators including the smallest, the largest and, if necessary, a mid-sized evaporator.

If the multi-temperature liquefied gas refrigeration unit can be operated with more than two evaporators:

- The host unit shall be tested with a combination of three refrigeration evaporations: the smallest, the largest and a mid-sized evaporator;
- In addition, on the request of the manufacturer, the host unit may be tested with a combination of two evaporators: the largest and the smallest.

For each test, the following shall also be recorded:

- The flow, consumption and pressure of the liquefied gas used;
- The tension and the total intensity absorbed by the liquefied gas refrigeration unit.

By definition, refrigerant consumption is equal to mean mass consumption of refrigerant throughout the test in question, the duration of which shall be 3 hours or more.

The mean over 15 minutes of air intake temperature (for ‘indirect’ units) or of air temperature inside the body (for ‘direct’ units) must comply with the expected class temperature ±1K.

The tests shall be conducted in the modes prescribed by the manufacturer.

9.2.2 Determination of the maximum nominal refrigerating capacity of the host unit

The maximum nominal refrigerating capacity of the host unit in mono-temperature operation shall be measured with a combination of two or three refrigeration evaporators operating simultaneously at the same temperature. This test shall be conducted at -20 ºC and 0 ºC.

The maximum refrigerating capacity of a liquefied gas refrigeration unit shall be measured using the most powerful configuration sold by the manufacturer of the unit.

Tests shall be conducted using all evaporators which:

- Are activated and functional; and
- If applicable, have the same air intake temperature or, if applicable, the same air temperature inside the body.

The individual refrigerating capacity is estimated in two stages:

1. A pre-estimation (optional) to assess the refrigerating capacity: The estimation follows the process described in ATP with a variant for the electrical power dissipated in the calorimeter box. The power is adjusted throughout the test to maintain the evaporator air intake temperature at a constant level. The figure for the minimum power dissipated within the calorimeter box during the test is reduced by 5%. An applicant who does not wish to carry out the test must provide the relevant figure found in the laboratory.

   Determination of the refrigerating capacity: the minimum found in 1. or provided by the applicant is determined:

   (a) The set point of the liquefied gas refrigeration unit is set at the chosen test temperature;

   (b) The electrical power dissipated in the calorimeter box is adjusted and set before initiating the test.

   The nominal refrigerating capacity at -10 °C shall be calculated by linear interpolation of the capacities at -20 °C and 0 °C.

   A single additional test of 1 hour shall be conducted with the smallest tank sold with the unit to quantify the impact of its volume on the regulation of refrigerating capacity. The new refrigerating capacity obtained shall not vary by more than 5% from the lower value or compared to the value found with the tank used for the tests of 3 hours or more. In the case of a greater impact, a restriction on the volume of the tank must be included in the official test report.

9.2.3 Determination of the individual refrigerating capacity of each refrigeration evaporator of a liquefied gas refrigeration unit

The individual refrigerating capacity of each refrigeration evaporator shall be measured in solo operation with the host unit. The test shall be conducted at -20 °C and 0 °C, as prescribed in paragraph 9.2.2.

The individual refrigerating capacity at -10 °C shall be calculated by linear interpolation of the capacities at -20 °C and 0 °C.

9.2.4 Determining the remaining effective refrigerating capacity of a liquefied gas refrigeration unit in multi-temperature operation at a reference heat load

Determination of the remaining effective capacity of a liquefied gas refrigeration unit requires the simultaneous use of two or three refrigeration evaporators, as follows:

- For a two-compartment unit, the refrigeration evaporators with the highest and lowest individual refrigerating capacities;
- For a three-compartment unit, the same refrigeration evaporators as above and a third evaporator with an intermediate refrigerating capacity.

Setting of the reference heat load:

- The set points of all but one of the refrigeration evaporators shall be set in such a way as to obtain an air intake temperature, or, if not applicable, an air temperature inside the body, of 0 °C;
- A heat load shall be applied to each calorimeter/refrigeration evaporator pair under control of the thermostat, except the one not selected;
- The heat load must be equal to 20% of the individual refrigerating capacity of each refrigeration evaporator at -20 °C.

Once the effective capacity of the remaining evaporator has been determined, the test shall be repeated after conducting a circular permutation of the calorimeter/refrigeration evaporator pairs, which must be at -20 °C.

For refrigeration units with three compartments, a test shall be conducted of the effective refrigerating capacity with a two-compartment configuration.

A functional validation is carried out by checking that the maximum nominal refrigerating capacity corresponds to the sum of the individual capacities of each evaporator installed to determine the capacity within 5% of the lower value.

9.3 Dimensioning and certification of refrigerated multi-temperature liquefied gas equipment

The dimensioning and certification of refrigerated equipment using liquefied gas refrigeration units shall be carried out as prescribed in annex 1, appendix 2, section 8.3, 'Dimensioning and certification of refrigerated multi-temperature equipment', of ATP, with the following capacity equivalents:

$P_{installed} = P_{nominal}$"