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# Economic Commission for Europe

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Item 5 (b) of the provisional agenda
**Proposals of amendments to ATP:**
**new proposals**

## Inclusion of an additional iterative method for tanks to Annex 1, Appendix 2 paragraph 1.2

### Submitted by the Government of Spain

## Introduction

1. The determination of the surface to be used in the calculation of coefficient K can be very complex and can involve physical parts not well defined by the geometry of the body of the equipment. In the current ATP text, method C was introduced for cases where the internal surface can be measured with accuracy, but not so the external surface.

2. There may be also cases where the opposite situation occurs, particularly in tanks, where it is possible to measure easily the outer surface, but it is very difficult – and even dangerous – to measure the internal surface.

3. For this case, it is proposed to use the same principle of the iteration procedure used in method C, but starting with the outer skin and to proceed inwards to calculate in a stepwise approach the internal surface using an iterative procedure, and including it as a new method D.

4. In informal document INF.2 of the seventy-seventh session "A scientific background on the iterative methods used in Annex 1, Appendix 2, section 1.2 to determine the value of the surface to be used in the determination of coefficient K in ATP isothermal tests" presented to this session, a topological analysis of the iterative method used in method C is included, and it is complemented by the same analysis applied to this additional case (see informal document INF.2 of the seventy-seventh session, 2 Section 3).

5. Applying the iterative method starting from the outer surface will allow a simpler treatment of tanks, as in many cases measuring the inner surface of a tank presents many risks from the point of view of occupational safety.

6. As the iteration runs inwards in this case, the parameter $\lambda$ must be adapted to this fact and an initial value $\lambda$= 0.035 W/m ºC is proposed (see justification of this value in informal document INF.2 of the seventy-seventh session), unless a more accurate estimate of the conductivity of the insulator can be made, either by physical measurement or by statistical studies of similar equipment.

# Calculation method proposed

7. The iterative method proposed is a self-coherent way to determine both the internal surface of the tank (or box, or container) and the K value for those cases where the outer surface is known, but the inner surface is not.

8. To apply it, the external surface $S_e$ has to be known. A test must be made to obtain the value of the heating power W and the difference of temperatures between the inner air and outer air during the test, ΔT. An initial coefficient $K_1$ is obtained as:

$$K_1 = \frac{W}{S_e \, \Delta T}$$

9. The iteration starts with the calculation of an initial thickness $d_1$ obtained as follows:

$$d_1 = \lambda \Delta T S_e / W$$

10. A value of λ= 0.035 W/m ºC is recommended for this method, unless the applicant has an accurate estimate of the conductivity of the insulator, either by physical measurement or by statistical studies of similar equipment (see also documents ECE/TRANS/WP.11/2021/03 and informal document INF.2 of the seventy-seventh session).

11. Thickness $d_1$ is applied to deduce the internal surface, starting from the known external surface. To deduce the internal surface $S_{i1}$ from the external surface and the thickness, knowledge about the general geometrical shape of the tank must exist (for example, tank is cylindrical), and the appropriate geometrical calculations have to be made. Therefore, this method can only be applied if the person responsible for the test can solve the involved geometric calculations. The next step is to calculate $S_1$ as:

$$S_1 = \sqrt[2]{S_{i1} \, S_e}$$

12. This new surface value leads to a new estimate of K, which is:

$$K_2 = \frac{W}{S_1 \, \Delta T}$$

13. And a new thickness $d_2$ is calculated as:

$$d_2 = \lambda \Delta T S_1 / W$$

14. The iteration continues until convergence on K is obtained, simultaneously as the convergence on S and d.

15. As an practical application of this method for the case of a cylindrical tank, with external radius R and length L, the equations corresponding to the external surface, and the internal surface obtained considering the external surface and the thickness are the following:

$$S_e = 2\pi R^2 + 2\pi \text{ RL}$$

$$S_{i1} = 2\pi(R - d_1)^2 + 2\pi(R\text{-}d_1)\,(L\text{-}2d_1)$$

16. To better introduce this method, it is proposed to include it as a new method D after the present method C. Additionally, text has to be introduced into the initial part of 1.2, to ensure that this method is used for the appropriate cases only (for tanks, and not for panel vans). To further clarify the use of method D and method C, small editorial amendments are proposed for method C.

17. The amendments proposed in document 2021/03 to method C are additional to those proposed here for method C.

18. These amendments should apply to tanks manufactured after the date of entry into force of the provision, as far as the test to determine K is concerned. The new method can be used in verification tests of tanks already in operation. No transitional period is necessary for their implementation.

# Proposed amendments

19. Proposal 1: Modify Annex 1, appendix 2, section 1.2 (new text underlined, deleted text stricken through) as follows:

> 1.2 The mean surface area S of the body is the geometric mean of the inside surface area $S_i$ and the outside surface area $S_e$ of the body:
>
> $$S = \sqrt{S_i \cdot S_e}$$
>
> In determining the two surface areas $S_i$ and $S_e$, structural peculiarities and surface irregularities of the body, such as chamfers, wheel-arches and similar features, shall be taken into account and shall be noted under the appropriate heading in test reports; however, if the body is covered with corrugated sheet metal the area considered shall be that of the plane surface occupied, not that of the developed corrugated surface.
>
> For calculating the mean surface area of the body of a panel van, the test station appointed by the competent authority shall select from one of the following three methods A-C. For calculating the mean surface area of the body of a tank vehicle, the test station appointed by the competent authority may use method A or D.

20. Proposal 2: Modify Annex 1, appendix 2, section 1.2 Method C (new text underlined, deleted text ~~stricken through~~) as follows:

> Method C. If ~~neither if the above is~~ methods A or B are not acceptable to the experts, the internal surface of the panel van shall be measured according to the figures and formulae in method B.
>
> The initial K value shall then be calculated based on the internal surface area, taking the insulation thickness as nil to start the iteration process. From this K value, the average insulation thickness is calculated from the assumption that λ for the insulation has a value of 0,025 W/m·ºC
>
> $$d = S_i \; x \; \Delta T \; x \; \lambda \; / W$$
>
> Once the thickness of the insulation has been estimated, the external surface area is calculated and the mean surface area is determined. The final K value is derived from successive iterations.

21. Proposal 3: Add after last paragraph of section 1.2 (of Annex1, appendix 2) the following text (new text underlined):

> Method D. If method A is not acceptable to the experts, the external surface of the tank shall be measured, taking into account the geometrical shape of the tank and the main values needed to model this shape (e.g. diameter, radius, length of cylinder, etc…). This method can only be used if the tank can be assimilated to regular geometrical forms (cylinder, cone, sphere) that can be described by mathematical equations.
>
> The initial K value shall then be calculated based on the external surface area, taking the insulation thickness as nil to start the iteration process. From this K value, the average insulation thickness is calculated from the assumption that λ for the insulation has a value of 0,035 W/m·ºC
>
> $$d = S_e \; x \; \Delta T \; x \; \lambda \; / W$$
>
> Once the thickness of the insulation has been estimated, the internal surface area is calculated taking into consideration the geometrical shape of the tank, and the mean surface area is determined. The final K value is derived from successive iterations.
>
> A different value of λ can be used in this method if the actual value of λ can be estimated by physical measurements of the properties of the main thermal insulator of the wall, or by statistical data of other ATP units of similar features.