United Nations ST/SG/AC.10/C.3/2023/2

Secretariat

Distr.: General
13 April 2023

Original: English

Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

Sixty-second session
Geneva, 3-7 July
Item 6 (d) of the provisional agenda
Miscellaneous proposals for amendments to the Model Regulations on the Transport of Dangerous Goods: other miscellaneous proposals

Units of measurement

Transmitted by the expert from Spain*

I. Introduction

1. Section 1.2.2.1 presents the different units of measurement to be used in the Model Regulations, including a table with the relationship between the main units of the International System of Units and other acceptable units.

2. Note [a] under 1.2.2.1 gives round figures for the conversion of different units.

II. Use of 'kg' as a unit of force

3. The kilogramme (kg) is introduced into 1.2.2.1 as a unit for the measurement of mass, and the Newton (N) as a unit for force, indicating the relation between them as:

$$1\ N = 1\ kg \cdot \frac{m}{s^2}$$

4. Nevertheless, in note [a] to 1.2.2.1, the kg is introduced additionally as a unit of force, by indicating that a conversion for the units of force is 1 kg = 9.807 N, which is incorrect. On the Earth, being the gravitational acceleration almost constant at g = 9.807 m/s², the relationship between N and kg can be considered $1\ kg \cdot 9.807\ \frac{m}{s^2} = 9.807\ N$, but this does not imply that the kg can be considered a unit of force. Mass and weight are different physical properties.

5. An alternative unit that could be used for this case is the kilopond (kp) or kilogram-force (kgf), defined as the force exerted by one kg of mass under standard gravity on the Earth's surface, which is 9.80665 $\frac{m}{s^2}$; the relationship to the N is therefore 1 kgf = 1 kp = 980665 N. Nevertheless, this unit does not comply with the International System of Units and is therefore not recommended to be used.

* A/77/6 (Sect. 20), table 20.6

6. Note [a] to 1.2.2.1 should be corrected, eliminating several references to the kg as a unit of force (see proposal 1). These proposed modifications are in accordance with the regulations from the International Committee for Weights and Measures (CIPM), specifically with the 9th edition of the International System of Units published in 2019[1].

7. As the use of the International System of Units has always been encouraged throughout the Model Regulations, this modification only has limited consequences on the rest of the text; an incorrect use of the kg as a unit of force can only be found in references to stacking (see paragraphs 13-19 below). A consequential amendment in the text of the definition of net explosive mass contained in 1.2.1 should also be made (see paragraphs 20 and 21 below).

III. Use of 'torr'

8. In note [a] under 1.2.2.1 the torr is introduced as an alternative unit for the measurement of pressure. The torr is named after Evangelista Torricelli, an Italian physicist and mathematician who discovered the principle of the barometer in 1644.

9. Historically, the torr was intended to be the same as one "millimetre of mercury" but is now defined as exactly 1/760 of a standard atmosphere (101 325 Pa). Nevertheless, it is not part of the International System of Units.

10. This unit is not used in the Model Regulations at all. Its old definition, through the mm of mercury (mass of a mm of mercury), would not be in accordance with the International System of Units; this has been overcome by its newer definition. Nevertheless, as it is not used in the Model Regulations, there seems to be no value in including it in note [a] under 1.2.2.1 (see proposal 2).

IV. General value of note [a] under 1.2.2.1

11. The proposed amendments shorten considerably note [a] under 1.2.2.1. The round figures applicable for conversion, which would be still included are the following:

(a) Relationship between Pa and bar for pressure: the exact value is $1\ Pa = 10^{-5}\ bar$; this is not an approximation, or a round figure. Its relationship is already clear from the main text in 1.2.2.1, the note does not add any further information.

(b) Relationship between J and cal: the exact value is 1 cal = 4184 J or 1 J = 0.2390057×10^{-3} cal; the approximation proposed in the Model Regulations (1 J = 0.239×10^{-3} cal) is easily found in literature and may only seldom differ from other approximations used. Relationships for related units (kcal/h) are also easily obtained.

(c) Use of St: the unit Stokes for kinematic viscosity is defined accurately (not a round figure) as $1\ St = 10^{-4}\frac{m^2}{s}$. This definition is included into the note, but the St is not used on any occasion throughout the Model Regulations.

(d) Use of P: the unit Poise for dynamic viscosity is defined accurately (not a round figure) as $1\ Pa \cdot s = 10\ P$. This definition is included into the note, but the P is not used on any occasion throughout the Model Regulations.

(e) The definition for the units of energy, power, kinematic viscosity and dynamic viscosity starting from the main units of the International System of Units are already included into the main table of 1.2.2.1; the note does not add any further value to the information contained there.

12. Therefore, the Sub-Committee may consider the complete deletion of the note under 1.2.2.1, as an alternative to proposals 1 and 2 (see alternative proposal 3).

[1] https://www.bipm.org/en/publications/si-brochure

V. Use of ‘kg’ as a reference for forces when stacking

13. The only occasions when the kg has been used as a reference for forces in the Model Regulations is for the stacking load.

14. The stacking test is described in 6.1.5.6. as follows: “the test sample shall be subjected to a force applied to the top surface of the test sample equivalent to the total weight of identical packages which might be stacked on it during transport”. This gives a relationship between the force applied (measured in N) and the weight (measured in N); it does not establish a direct relationship to the mass (measured in kg) and therefore the wording is accurate and in accordance with the International System of Units.

15. Also, the stacking test defined under 6.4.15.5 indicates an equivalency between the load and the weight.

16. Nevertheless, on several occasions, a reference is made directly to the stacking test load and its value in kg, which is in principle incorrect, as loads should be measured in N. This happens in the following occasions:

(a) Primary marking of IBCs under 6.5.2.1.1 (g):

“The stacking test load in kg. For IBCs not designed for stacking, the figure "0" shall be shown;”

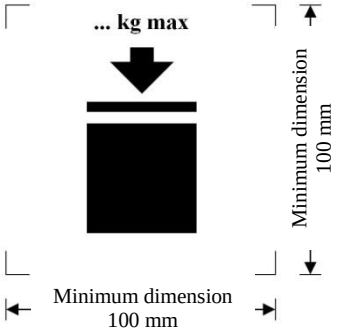
(b) Examples of marking in 6.5.2.1.3:

“... /the stacking test load in kg/ ...”

(c) Text and figures in 6.5.2.2.2:

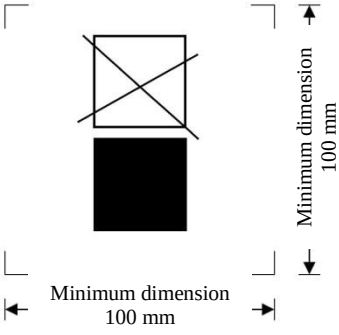
“The maximum permitted stacking load applicable shall be displayed on a symbol as shown in figure 6.5.1 or figure 6.5.2. The symbol shall be durable and clearly visible.

Figure 6.5.1



IBCs capable of being stacked

Figure 6.5.2



IBCs NOT capable of being stacked”

(d) Primary marking of large packagings under 6.6.3.1 (g):

“The stacking test load in kg. For IBCs not designed for stacking, the figure “0” shall be shown;”

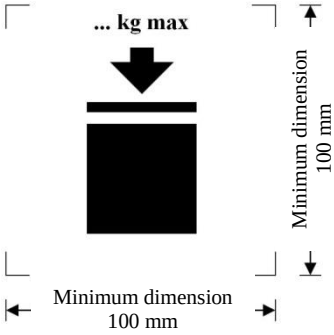
(e) Examples of marking in 6.6.3.2:

“... stacking load: 2 500 kg; ...” (twice)

(f) Text and figures in 6.6.3.3:

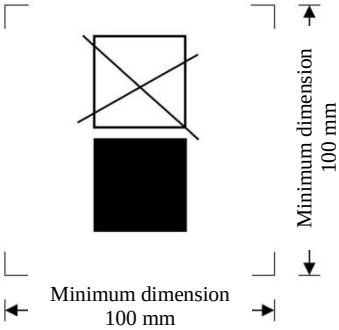
“The maximum permitted stacking load applicable shall be displayed on a symbol as shown in figure 6.6.1 or figure 6.6.2. The symbol shall be durable and clearly visible.

Figure 6.6.1



Large packagings capable of being stacked

Figure 6.6.2



Large packagings NOT capable of being stacked"

(g) Marking of bulk containers in 6.8.5.5 (g):

"The stacking test load in kg;"

17. The mark shown in 6.5.1 and 6.6.1 is very intuitive; it shows the maximum mass that can be stacked on the IBC surface without damage to the IBC. This mark should not be modified.

18. In the text of the definition, the term stacking load is not used. This wording is only used for the mark; it would be easy to refer there to the "stacking mass" instead of the "stacking load" or to the "mass used in the stacking test" instead of "stacking test load". These amendments are included in proposal 4.

19. Additionally, the wording used in 6.5.6.6.4 and 6.6.5.3.3.4 should be corrected, to be more in line with the definition; it should be adapted to the wording used for the stacking test in 6.1.5.6. and 6.4.15.5, relating load to weight and not to mass (see proposal 5).

VI. Net explosive mass

20. In the definition of "net explosive mass" in 1.2.1, an equivalency of the concepts of net explosive mass and net explosive weight is mentioned; even if the concepts are related, they do not represent the same concepts (see justification in paragraph 4), and this should be corrected (see proposal 6).

21. The net explosive weight (NEW) is introduced in 1.2.1, but not used in the Model Regulations, so this amendment has no further consequences.

VII. Proposals

A. Proposal 1

22. To eliminate the use of the kg as a unit of force, we propose to modify note [a] under 1.2.2.1 to read as follows (deleted text is shown in ~~stricken through~~):

[a] *The following round figures are applicable for the conversion of the units hitherto used into SI Units.*

~~*Force*~~	~~*Stress*~~
~~*1 kg = 9.807 N*~~	~~*1 kg/mm^2 = 9.807 N/mm^2*~~
~~*1 N = 0.102 kg*~~	~~*1 N/mm^2 = 0.102 kg/mm^2*~~

Pressure

1 Pa	=	*1 N/m^2 = 10^{-5} bar*	=	~~*1.02 × 10^{-5} kg/cm^2*~~	=	*0.75 × 10^{-2} torr*
1 bar	=	*10^5 Pa*	=	~~*1.02 kg/cm^2*~~	=	*750 torr*

~~*1 kg/cm²*~~	~~=~~	~~*9.807 × 10⁴ Pa*~~	~~=~~	~~*0.9807 bar*~~	~~=~~	~~*736 torr*~~	
1 torr	=	*1.33 × 10² Pa*	=	*1.33 × 10⁻³ bar*	~~=~~	~~*1.36 × 10⁻³kg/cm²*~~	

Energy, Work, Quantity of heat

1 J=1 Nm	=	*0.278 × 10⁻⁶ kWh*	~~=~~	~~*0.102 kgm*~~	=	*0.239 × 10⁻³ kcal*	
1 kWh	=	*3.6 × 10⁶ J*	~~=~~	~~*367 × 10³ kgm*~~	=	*860 kcal*	
~~*1 kgm*~~	~~=~~	~~*9.807 J*~~	~~=~~	~~*2.72 × 10⁻⁶ kWh*~~	~~=~~	~~*2.34 × 10⁻³ kcal*~~	
1 kcal	=	*4.19×10³J*	=	*1.16 × 10⁻³ kWh*	~~=~~	~~*427 kgm*~~	

Power

1 W	~~=~~	~~*0.102 kgm/s*~~	=	*0.86 kcal/h*			
~~*1 kgm/s*~~	~~=~~	~~*9.807 W*~~	~~=~~	~~*8.43 kcal/h*~~			
1 kcal/h	=	*1.16 W*	~~=~~	~~*0.119 kgm/s*~~			

Kinematic viscosity

1 m²/s	=	*10⁴ St (Stokes)*	
1 St	=	*10⁻⁴ m²/s*	

Dynamic viscosity

1 Pa · s	=	*1 Ns/m²*	=	*10 P (poise)*	~~=~~	~~*0.102 kgs/m²*~~	
1 P	=	*0.1 Pa · s*	=	*0.1 Ns/m²*	~~=~~	~~*1.02 × 10⁻² kgs/m²*~~	
~~*1 kgs/m²*~~	~~=~~	~~*9.807 Pa · s*~~	~~=~~	~~*9.807 Ns/m²*~~	~~=~~	~~*98.07 P*~~	

B. Proposal 2

23. To eliminate the use of the unit torr, we propose to modify the section on "*Pressure*" in note [a] under 1.2.2.1 to read as follows (deleted text is shown in ~~stricken through~~):

Pressure

1 Pa	=	*1 N/m² = 10⁻⁵ bar*	=	*1.02 × 10⁻⁵ kg/cm²*	~~=~~	~~*0.75 × 10⁻² torr*~~	
1 bar	=	*10⁵ Pa*	=	*1.02 kg/cm²*	~~=~~	~~*750 torr*~~	
1 kg/cm²	=	*9.807 × 10⁴ Pa*	=	*0.9807 bar*	~~=~~	~~*736 torr*~~	
~~*1 torr*~~	~~=~~	~~*1.33 × 10² Pa*~~	~~=~~	~~*1.33 × 10⁻³ bar*~~	~~=~~	~~*1.36 × 10⁻³kg/cm²*~~	

C. Proposal 3 (alternative to proposals 1 and 2)

24. Delete note [a] under 1.2.2.1 and renumber notes [b] and [c] as [a] and [b].

D. Proposal 4

25. Modify the following paragraphs as follows (deleted text is shown in ~~stricken through~~, new text in **bold**):

(a) Primary marking of IBCs under 6.5.2.1.1 (g):

"The **mass used in the** stacking test ~~load~~ in kg. For IBCs not designed for stacking, the figure "0" shall beshown;"

(b) Examples of marking in 6.5.2.1.3:

"... /the **mass used in the** stacking test ~~load~~ in kg/ ..."

(c) Text in 6.5.2.2.2:

"The maximum permitted stacking **mass** ~~load~~ applicable shall be displayed on a symbol as shown in figure 6.5.1 or figure 6.5.2. The symbol shall be durable and clearly visible."

(d) Primary marking of large packagings under 6.6.3.1 (g):

"The **mass used in the** stacking test ~~load~~ in kg. For IBCs not designed for stacking, the figure "0" shall be shown;"

(e) Examples of marking in 6.6.3.2:

"... stacking **mass** ~~load~~: 2 500 kg; ..." (twice)

(f) Text in 6.6.3.3:

"The maximum permitted stacking **mass** ~~load~~ applicable shall be displayed on a symbol as shown in figure 6.6.1 or figure 6.6.2. The symbol shall be durable and clearly visible."

(g) Marking of bulk containers in 6.8.5.5 (g):

"The **mass used in the** stacking test ~~load~~ in kg;"

E. Proposal 5

26. Modify the following paragraphs as follows (deleted text is shown in ~~stricken through~~, new text in **bold**):

"6.5.6.6.4 *Calculation of superimposed test load*

The **mass** ~~load to be~~ placed on the IBC shall be 1.8 times the combined maximum permissible gross mass of the number of similar IBCs that may be stacked on top of the IBC during transport."

"6.6.5.3.3.4 Calculation of superimposed test load

The **mass** ~~load to be~~ placed on the large packaging shall be 1.8 times the combined maximum permissible gross mass of the number of similar large packaging that may be stacked on top of the large packaging during transport."

F. Proposal 6

27. Modify the definition of "*Net explosive mass*" in 1.2.1 to read as follows:

"*Net explosive mass (NEM)* means the total mass of the explosive substances, without the packagings, casings, etc. *(Net explosive quantity (NEQ)~~,~~* ***or*** *net explosive contents (NEC)~~, or net explosive weight (NEW)~~ are often used to convey the same meaning.);*"

VIII. Justification

28. Ensuring a more systematic approach and a better rationale in the Model Regulations helps to create clearer legal texts and to avoid different criteria among different countries and inspection services, and thus helps to implement target 16.6 of the 2030 Agenda for sustainable development (Develop effective, accountable and transparent institutions at all levels).