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Confronting ISO: On the Use of the dBA Symbol for A-Weighted Sound Levels

Enfrentando a la ISO: Sobre el uso del símbolo dBA para los niveles sonoros con ponderación A

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***Abstract*— The International Organization for Standardization (ISO) recommends the symbol dB for all instances where decibel units are used, particularly in the cases of quantities such as the A-weighted and C-weighted sound pressure levels, ruling out the symbols dBA y dBC. In this paper several arguments are put forward as to why such recommendation is mistaken and should be revised, taking into account that the dB prefix is used in the symbols of many substantially different units as well as the fact that there are examples of situations where the criterion hereby proposed is accepted.**

Keywords: ISO; units; decibel A.

***Resumen*— La Organización Internacional de Normalización (ISO) recomienda el símbolo dB para todas las instancias de uso de unidades de decibel, en particular en los casos de cantidades como el nivel de presión sonora con ponderación A y C, censurando los símbolos dBA y dBC. En este trabajo se argumenta por qué ello es un error atendiendo al hecho de que el prefijo dB se utiliza en los símbolos de muchas unidades sustancialmente diferentes y a la existencia de ejemplos de situaciones donde se sigue un criterio similar al propuesto.**

Palabras clave: ISO; unidades; decibel A.

I. Introduction

The International Organization for Standardization (ISO) recommends the symbol dB for all instances where decibel units are used, particularly in the cases of quantities such as the A-weighted and C-weighted sound pressure levels, ruling out the symbols dBA y dBC.

In order to make it clear that the stated value has been A-weighted, it is required that such condition be expressed as a subscript in the quantity symbol, not in the unit symbol. For instance,

$$L_{\mathrm{Aeq}} = 85 \text{ dB}. \quad (1)$$

The definition of the decibel itself and its symbol dB are provided in International Standard ISO 80000-3 [1], while the recommendation preventing the addition of any suffix indicating the weighting is established in International Standard ISO 80000-8:2006, which states, in a note attached to the definition of bel and decibel,

"NOTE: The addition of a postscript to indicate the frequency weighting e.g. dB(A), is incorrect. This information should be carried by the quantity symbol, e.g. L_{A}." [2]

This sort of recommendation is also included in the report of the International Bureau of Weights and Measures (BIPM), which states that the unit symbols should not have any attachment, such as subscripts or suffixes, which carry information about the quantity being represented using that unit. Such information should be included in the quantity symbol:

"(...) the unit symbol should not be used to provide specific information about the quantity, and should never be the sole source of information on the quantity. Units are never qualified by further information about the nature of the quantity; any extra information on the nature of the quantity should be attached to the quantity symbol and not to the unit symbol." [3]

A similar criterion is expressed in the document of the International Organization of Legal Metrology OIML D 2, Section 1.5:

"It is not permitted to add any kind of adjective or sign to the legal names or legal symbols of units. (For example, electrical power is expressed in watts, W, not in electrical watts, We)." [4]

These prescriptions are essentially correct as they are based on an economy principle, inasmuch they discourage assigning different symbols to the same unit. The question is, thus, whether or not in the present case they are being applied correctly. We will attempt to provide an answer in the next section.

II. Inadequate Application of a Criterion

We consider that applying these prescriptions to the case of the decibel A and similar units is a mistake that has been repeated for a long time and should be corrected by adopting more suitable unit symbols such as dBA, dBC, etc., as it was common practice decades ago and as is still customary in a significant proportion of the scientific and technical literature, as well as in normative and regulatory documents. In what follows, an attempt will be done to substantiate this proposal.

In the first place we are not in the same situation as in the example provided by the BIPM publication cited above, which states that to indicate that a given quantity U is the maximum of an oscillating signal it would not be correct to write

$$U = 1000 \text{ Vmax}. \quad (2)$$

Instead, it should be notated as

$$U_{\text{max}} = 1000 \text{ V}. \quad (3)$$

In this case there is absolutely no difference between the units represented by the symbols Vmax and V; they are, indeed, one and the same, so it is reasonable to avoid the use of the symbol Vmax when we already have the symbol V to represent such unit. There is no difference whether it is an instantaneous value, the maximum or the effective (root mean square) value.

In the case under discussion, the situation would be similar as if one attempted to express the peak value of a sound pressure level as

$$L_{\text{p}} = 102 \text{ dBpeak}. \quad (4)$$

to indicate that the referred value is the maximum in a given interval. There would be no difference between the unit whose symbol is dBpeak and the one whose symbol is dB. There would be no difference either between the units used to quantify sound pressure and barometric pressure.

However, the decibel A is ***not*** the same unit as plain decibel. To begin with, the sound pressure level is not just a logarithmic form of the ratio between two ***arbitrary*** sound pressures, as is the case of the logarithmic expression of a gain, an attenuation or a signal-to-noise ratio, i.e., relative quantities, which, by the way, is the only situation in which the dB is accepted as a unit outside the SI to be used with the SI [3]. Rather, it is an absolute unit used to express a physical quantity univocally, just as the metre is not just a unit to express the ratio between two lengths (e.g., the length to be measured and the reference length) but to represent the value of a length or distance. This is so because there exists a specific standard reference, unlike the case of a gain, where we can speak of the gain of a linear system regardless of the particular values of the input and output signals.

In order to clarify this concept, the decibel, as a unit used in acoustics, is an example of a unit to express what is known as the ***level of a field quantity***,[1] where there is a concrete reference, in this case 20 μPa, which has been universally accepted[2] and is defined in many standards, that links the sound pressure levels expressed using this unit to the pascal or N/m^2, unit of sound pressure in the SI. Another similar example is the dBV, used in sound systems, which by convention uses a concrete reference equal to 1 V. We could hardly state that the "V" that accompanies as a suffix the particle "dB" in the symbol dBV is an attachment that only informs the nature of the quantity being measured, as would be the case in the mistaken use of symbols Vmax or Vef to connote that we are referring to a maximum or an effective value.

By the same token, the acoustic decibel is not just a unit for the logarithm of the non-dimensional ratio between two generic values of sound pressure but, rather, between the value to quantify and a concrete reference. The fact that for historical reasons we keep using the symbol dB for this unit is unfortunate, since it gives rise to several misunderstandings, including the one we are referring to. It is tolerated because of the long tradition which dates back to the very origins of acoustic metrology. It could be replaced by dBp or, as is customary in many authors, dBSPL.

Now, using the same symbol dB for the A-weighted sound pressure level is doubly confusing, as we are referring to a completely different kind of measurement, where there is a filtering process prior to the actual measurement which causes that in many cases where the sound pressure levels of two signals are identical, the A-weighted values differ, and the other way around. For instance, two sounds of 100 Hz and 1000 Hz, both of 60 dB, have A-weighted values of 41 dBA y 60 dBA respectively (see figure 1):

$$L_{\text{A1}} = 60 \text{ dB} + A(100 \text{ Hz}) = 60 \text{ dB} - 19 \text{ dB} = 41 \text{ dBA} \quad (5)$$

$$L_{\text{A2}} = 60 \text{ dB} + A(1000 \text{ Hz}) = 60 \text{ dB} + 0 \text{ dB} = 60 \text{ dBA} \quad (6)$$

whereas a sound of 100 Hz and 60 dB has an A-weighted value of 41 dBA, the same as one of 630 Hz and 43 dB:

$$L_{\text{A1}} = 60 \text{ dB} + A(100 \text{ Hz}) = 60 \text{ dB} - 19 \text{ dB} = 41 \text{ dBA} \quad (7)$$

$$L_{\text{A2}} = 43 \text{ dB} + A(630 \text{ Hz}) = 43 \text{ dB} - 2 \text{ dB} = 41 \text{ dBA} \quad (8)$$

It is worth to note that the "A" attached as a suffix to the unit symbol dB is not providing information on the quantity but on its dimension, much the same as when in the case of the symbol °C a "C" is attached to the symbol ° without the "C" qualifying the quantity. It is attached to denote that they are two different units since the angle and the Celsius temperature are two type of quantities which are dimensionally different. The same as in the case of the dB, here the ° has been traditionally used for angles and temperatures, which is also unfortunate but honors tradition. Interestingly, from the inception of the SI the character ° is not used any longer in the symbol of the absolute or thermodynamic temperature, the kelvin (formerly known as *degree Kelvin*), whose symbol is just K [3].

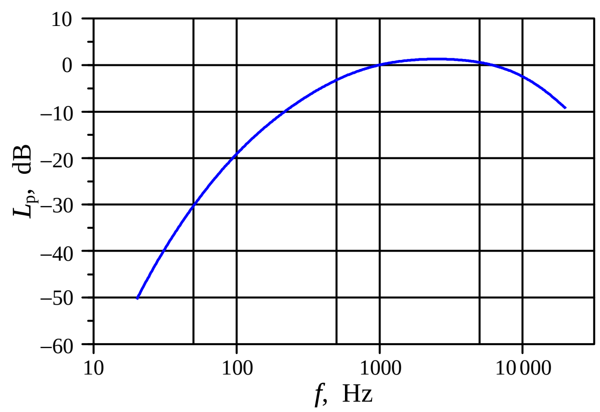

Fig. 1. Frequency response of an A-weighting filter [5].

[1] A field quantity (also called a root-power quantity) is a quantity such as sound pressure or electric field whose square is proportional to power.

[2] For air-borne sound. In other media it may differ; for instance, in water it is 1 μPa.

III. The Same Name for Many Units

What is essentially happening here is that several different units have been emerging including the prefix dB just because there is a logarithmic process involved in the computation of the quantity values from quantities that are directly measured, [3] not because they are all quantity-informative variants of a single unit. Using the same symbol for units so diverse as the sound pressure level dB, the sound intensity level dB, the spectral level dB, the gain, attenuation or signal-to-noise dB, the voltage level dB (in its variants dBV, dBu, dBmV, dBμV, dBkV), the electric power level dB (dBm, dBW) is misleading. The use of a single unit for all of them because of a fundamentalist interpretation of the cited BIPM text is cause of confusion, especially in disciplines such as sound technology where several of such quantities coexist. In technology disciplines it is frequent to find decibel quantities expressed as

$$-26 \text{ dB re } 1 \text{ V}, \tag{9}$$

where the “re” means “referred to”. This is cumbersome since it takes a unit, a clarifying particle and a reference quantity just to make clear what we are talking about. It should be replaced by

$$-26 \text{ dBV}. \tag{10}$$

IV. A Similar Case in Optics

In order to see the question from another perspective we can consider an extreme case in a similar discipline, optics, and one of its technological branches, lighting technology. Here we come across the case of the candela (cd), the SI unit for luminous intensity, I_V, used to quantify the brightness of a light source ([3], p. 135). This quantity is defined as

$$I_V = \frac{d\Phi_V}{d\Omega}, \tag{11}$$

where Ω is the solid angle and Φ_V, the radiant flux, which is computed in the spectral domain as

$$\Phi_V = K_m \int_{380}^{780} \frac{d\Phi_e}{d\lambda} V(\lambda)\, d\lambda, \tag{12}$$

Here $d\Phi_e/d\lambda$ is the radiant flux per unit wavelength and $V(\lambda)$ is the luminous efficiency, which accounts for the photopic (daylight) spectral sensitivity of the eye (figure 2). K_m is the ***maximum luminous efficacy***, equal to 683 lm/W. [6]

Except for the constant K_m, tailored so that the luminous intensity can be expressed in candelas, the candela would be dimensionally equivalent to a watt per steradian (W/sr), i.e., the unit for radiant intensity. But the candela is, indeed, a completely different type of unit, since the luminous intensity is the result of the spectral weighting process implied in (12). In a similar fashion as the A weighting, the luminous efficiency weights the radiant signal according to the average visual sensitivity for each frequency (or wave length). To some extent, both units are based on organoleptic characteristics of the respective stimuli.

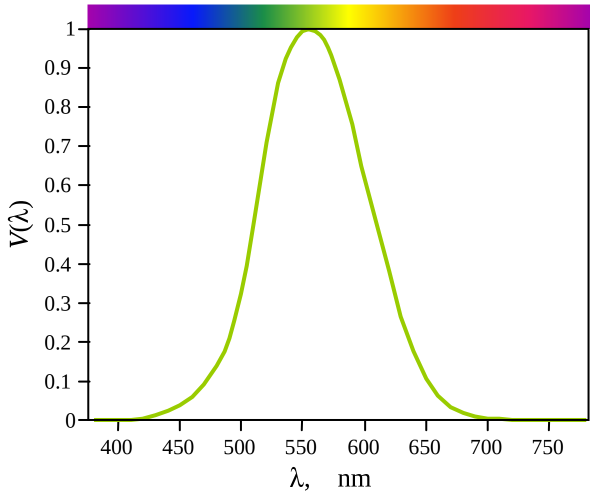

Fig. 2. Luminous efficiency for photopic (daylight) vision used to compute luminous intensity (reference color hues are only approximate)

The most noteworthy aspect is that the candela not only has the status of an independent unit with its own symbol included, cd, (even if it is dimensionally equivalent to the W/sr), but it has been adopted as one of the seven fundamental units of the SI!

The adoption of the candela as a fundamental unit[4] of the SI means an implicit acknowledgment of the fact that the frequency weighting (filtering previous to actual measurement) requires a substantially different unit with its own unit name and symbol. The same happens regarding A-weighted sound pressure level, and even if we do not claim that the corresponding unit should be adopted as a fundamental unit, we do assert that it deserves its own symbol, the dBA.

The discussion is bogged down by the unfortunate fact that the symbols dB and dBA begin with the same prefix, causing the impression that the A is just a clarifying suffix when it is clearly not.

V. The Case of the Phon

Getting back to acoustics, let us consider the case of the psychoacoustic quantity known as *loudness level*.[5] It is quite a particular case in that there is not only a spectral weighting but such weighting further depends on the level of the signal [8]. A special unit, the phon, whose symbol is equal to the name of the unit, has been introduced to express loudness level. Dimensionally it would be the same as the decibel, and in fact the loudness level and the sound pressure level have the same values at 1 kHz. Since the name of the unit does not include the prefix “dB” there has been no objection to its use. Had it been called differently and a dB symbol (such as dBL or dBph) been introduced, it would have probably suffered the same fate as the dBA.

VI. The dBA in the Literature and Other Documents

On the other hand, the use of the dBA is customary in many bibliographic sources, including several books, for

3 A notable exception is the pH (potential of hydrogen), a logarithmic quantity used in chemistry to express the concentration of hydrogen ions in a solution, which does not have a unit. It is usually considered a scale.

4 The fundamentalness of the candela has been challenged and the lumen been proposed as more fundamental [7].

5 It is actually a psychophysical quantity which is intended as an intermediate step for computing loudness.

instance [9], [10], some of which are highly regarded in the acoustical education community, such as [11]. Other authors prefer to notate it dB(A) ([12], [13]), which, in our opinion, is less economical and introduces unnecessary non-alphabetic symbols with a mathematical interpretation that might cause confusion (a functional notation). But all the same, they acknowledge the need of a different unit symbol. In [14] all three conventions (dB, dB(A) and dBA), are used depending on the author of each chapter. The scientific literature contains plenty of examples using these symbol units ([15]) and the same holds for PhD theses ([16], [17]).

In documents from the World Health Organization (WHO) dealing with community or occupational noise the use of these units is also frequent. For instance, [18] uses primarily dBA; [19] uses both dBA and dB(A), while [13] and [20] use dB(A).

There are also many examples in regulatory documents, such as in the Law 1540 from the Autonomous City of Buenos Aires, which uses both dBA and dB(A) [21], and the basic document of protection against noise in force in Spain, which uses dBA [22]. The Noise Code from New York City 0 uses dB(A), while Article 8.04 from the Code of Ordinances of the City of Paris uses dBA [24]. The Noise Abatement Ordinance in force in Switzerland [25] uses dB(A).

It is noteworthy that even in relatively recent ISO standards it is possible to find cases where the dBA symbol is used (however, they could be residual cases or cases where the main subject of the standard is not acoustics so reviewers might have overlooked the non-conformity with the style requirements). Two examples are the International Standards ISO/IWA 24:2016 [26] and ISO 16976:2023 [27]. Several ITU standards use the symbol dBA as well, such as ITU-R BS.1771-1 0, ITU-T H.872 [29]. There exists also an ITU recommendation, ITU V.574-5 which recommends, in its clause 8 about special notations [30]:

> "For absolute acoustic pressure level (see § 6.8)
> dBA, dBB or dBC: weighted acoustic pressure level with respect to 20 μPa, mentioning the weighting curve used (curves A, B or C, see International Standard IEC 61672)."

The Standard IEC 60268-16, on the other side, uses an atypical variant: dB A, with a blank between "dB" and "A" [31]. Though we do not recommend this practice, it is further evidence that plain dB does not convey the full story.

It is worth mentioning that until the last version of the argentinean standard IRAM 4062 on annoying community noise, published in 2021 ([32]), the symbol units used to express A-weighted and C-weighted sound pressure levels were dBA and dBC respectively. In the new version published in 2025 ([33]) the suffixes have been dropped, probably due to pressure to adhere completely to ISO's styling directives.[6] This is particularly problematic since this specific standard is used as a *de facto* reference in many local ordinances and regulatory documents dealing with noise pollution, so it transcends widely the sphere of technicians and noise control specialists. The impact is uncertain, but there is the risk that several misunderstandings could impair the effects of the standard. Indeed, some non-specialists could be led to believe that there has been a change in the indicator used to assess noise pollution.

[6] The IRAM is the national standard organization from Argentina and a member of ISO.

VII. Conclusion

We can conclude that the use, not only in academic but also in regulatory and normative texts, of a specific symbol (such as dBA or dB(A), with preference of the former) to express the quantities that result from the application of a frequency weighting is quite widespread. This reveals that there are many specialists that acknowledge the need to distinguish both decibel types and that the corresponding symbology is a logical answer to that need. The cases of the candela and the phon should be carefully considered since they are examples of application of different criteria for a similar conceptual problem.

Several of the preceding arguments have been submitted to the ISO or its Committee ISO/TC 43 (which deals with the study of standards in connection with acoustics) from 2011 onward. The reply has varied as to the attention and consideration that the observations have received, but not in terms of the final response, which has been monolithic in its rejection to the proposal ([34], [35]) on the basis that the issue had been already discussed and the decision had been final. In some cases, after the author's reply with more arguments, no further reply was received. In view of all the evidence exposed, the ISO and other standard organizations, either national and international, should revise the position which proscribes the use of symbols such as dBA or dBC.

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