

SINGLE NUMBER RATING OF ENCLOSURES

M Asselineau

Peutz & Associés, 103 Bd Magenta, 75010 Paris, France

INTRODUCTION

This paper deals with the concept of single number rating, as applied to the noise reduction performances of enclosures. This concept was subjected to a preliminary investigation by ISO/TC43/SC1/WG36 as a complement of its work on the assessment of the acoustical performances of noise attenuating devices. That preliminary investigation featured a questionnaire that was primarily directed to manufacturers. It appeared that while the acoustical engineer usually appreciates octave band information, the average user or retailer usually prefers a single number rating, that speeds up classification.

First, the concept of single number rating is briefly described. Then, a catalogue of either existing or potentially usable single number rating systems is examined.

A selection of those single number rating systems is then applied to different enclosures, and their value is compared to the actual A weighted noise reduction obtained for three different sound sources.

An attempt is then made to develop a single number rating system and apply it to enclosures. Tests show that a single number rating system alone is not sufficient and must be supplemented by a source dependent parameter.

PRELIMINARY CONSIDERATIONS

A single number rating might be regarded as a useful tool when it comes to a quick search through a catalog of products. It may be regarded as a simplification of the data, that can be felt as comfortable to both the acoustical engineer and the average customer, not to mention the manufacturer attempting to display quickly the basic acoustical information.

However, such a simplification might prove quite treacherous if the noise spectra is not properly taken into account. Let us see what kind of single number rating system is used around :

- In building and room acoustics it is quite common to describe the sound insulation between spaces using a single number rating. Now, the average spectra of the noise sources to be found in such places is rather well known. It is also quite common to describe the reverberation time in such places using

only the 1000 Hz octave band value. More to the point, whether the sound insulation descriptor is known as R_{pink} or R_w or STC it has been accepted and used by acousticians and architects alike.

- In industrial acoustics there is no officially known single number rating system. However, the acoustical engineer will often proceed on a case through a preliminary diagnosis and survey that will enable him to know the noise sources to be accounted with. Knowing the noise sources involved, on choosing between orientations the acoustical engineer will often choose the most critical octave band and conduct a very rough estimate of the A weighted efficiency of a complete noise control solution (e.g. choosing between an enclosure around a noise source, a cabin around the workstation, or an absorptive ceiling overhead, and deciding about the efficiency of each of those components). It must be stressed out that on such occasions the acoustical engineer is implicitly referring his single number oriented work to a given noise spectrum. Once a complete solution has been defined it is even possible to state the acoustical objectives in dB(A), with a detailed investigation being pursued only if problems are likely to appear.

To sum up the needs a single number rating must simultaneously provide help (and never be a hindrance) to :

- non acoustically educated people (this point prevent the use of a so called "single number rating" with indices, which could only confuse them);

- acoustical engineers in search of a short cut when attempting to define a complete solution (who might nevertheless need later on a complete octave band description, that must therefore not be denied to them);

- manufacturers attempting to answer a product call.

In order to fit a large panel of products, it is advisable to use a spectrum that covers various situations. Such a spectrum might be a pink noise or an "industrial noise" specifically defined.

DEVELOPMENT OF A SINGLE NUMBER RATING FOR ENCLOSURES

The use of a single number rating has been well established in building acoustics, as there more or less is some consensus regarding the emission spectrum involved. Now, a quite impressive variety of spectra can be found in the industry, that quite often feature a broader frequency range : figure 1 displays a few examples of such spectra, that were used during the single number rating systems tests. While it does not seem realistic to try and average them, using three different reference spectra (low, medium, high) will only complicate the matter. One might therefore find some interest in choosing a "neutral" spectrum such as pink noise.

However, some of the manufacturers who were contacted during the ISO TC43/SC1/WG36 attempts did point out that they were aware of the existence of a single number rating system, but most unfortunately they did not forward any description of such system. As a basis of discussions, table I submits some possible ways of developing a single number rating system, either from existing material or along brand new lines. Those single number rating systems were applied to various enclosures ranging from a light homemade one to a heavy and well sealed concrete one (figure 2), that were supposed to be applied to the noise sources of figure 1 (i.e. #1 high frequency predominant, #2 low frequency predominant, #3 broadband), and the relevant single number rating value was compared to the A weighted sound level difference at the workstation between the non enclosed and the enclosed situations.

Type	Strong point	Weakness
R_w	- used in building ac. - defined in ISO 717	- based on a speech spectrum - contributions under 100 Hz or above 3150 Hz not accounted for
STC	- used in building ac.	as above
extended R_w	easily derived from ISO 717	not linked to a real spectrum
A_{pink}	- used in building ac.	dependent on the upper and lower limits of the spectrum
C_{pink}	could easily be derived from the above	as above

Table I : Some possible single number rating systems

On attempting to apply any single number rating without bothering to account for the source characteristics, it turns out that the A_{pink} (on the 50 to 10000 Hz range) gives a fair assessment of the A weighted sound level reduction for sources 1 and 3 but a poor one for source 2; the C_{pink} fares slightly better, while the R_w , STC, and extended R_w (on the 50 to 10000 Hz range) do not provide a fair assessment of the A weighted sound level reduction.

In order to take easily into account the source characteristics, a correlation was sought between the A weighted sound level difference at the workstation between the non enclosed and the enclosed situations, and a linear expression featuring the relevant single number rating value of the enclosure and the harmonic index (difference between A and C weighted levels) of the noise source. It turns out again that of all the single number rating systems listed in table I, it is the A_{pink} , combined to the harmonic index, that gives the best prediction of the A weighted sound level reduction, with a 3 dB(A) accuracy. Interestingly enough, an even better correlation is achieved between the C_{pink} , combined to the harmonic index, and the C weighted sound level reduction.

COMMENTS AND CONCLUSIONS

Due to the large variety of spectra involved in the industry, it is not possible to use a single number rating (as one single value) that will accurately traduce the performances of an enclosure in terms of A weighted sound reduction. However, the combination of a pink weighted single number rating (such as the A_{pink} or the C_{pink}) on the 50 to 10000 Hz range with the harmonic index of the noise source gives a realistic assessment of the A or C weighted sound level reduction.

If a single number rating is to be developed and used successfully, further investigations are badly needed either to confirm the potential of the A_{pink} or the C_{pink} on the basis of measurements performed using ISO 11546, or to try and develop another approach.

REFERENCES

[1] ISO/TC43/SC1/WG36 : Some preliminary considerations about a single number rating of enclosures, document N93, September 1995

[2] Determination of sound attenuation performances of enclosures
part 1 measurements in small enclosures under laboratory conditions,
ISO 11546-1, 1994
part 2 measurements of in situ sound insulation performance,
ISO 11546-2, 1994

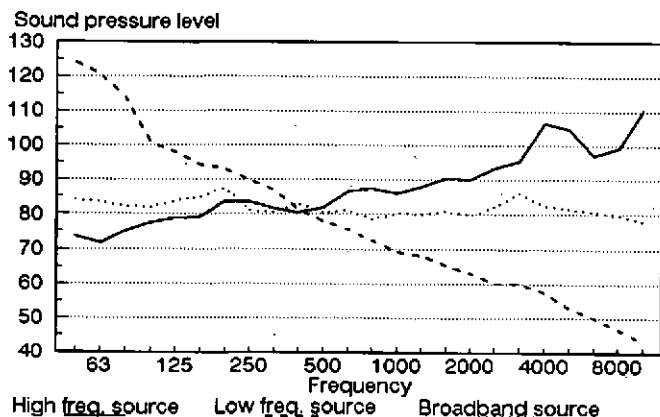


Figure 1 : Some examples of industrial noise sources

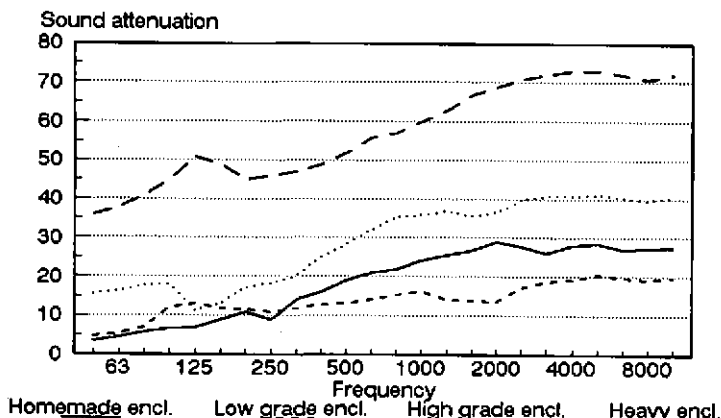


Figure 2 : Some examples of enclosures