INDUSTRY NOISE: LEGISLATION AND MEASURE METHODS

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APAT

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1 – TECHNICAL NORMS OF THE ITALIAN REGULATIONS

CONTINUOUS CYCLE SYSTEM

Continuous productive cycle system are intended:
a) Those for which it is not possible to interrupt the activity without causing damages to the same system, danger of accidents, product alteration; or those for which there is need of continuity finalized to ensure supply of an essential public service;
b) Those whose running is regulated by national employment contract or by legislation, concerning 24 hours weekly cycles, except maintenance requirements.

Current continuous productive cycle systems must comply with the differential principle, when absolute immission values are not met.
For continuous productive cycle systems, built up after the Decree went into force, compliance with the differential principle is the necessary condition for the issue of the authorization.

NO-CONTINUOUS CYCLE SYSTEM

For such type of systems the limit values of emission and immission hold, referred to the classes of end-use destination of the territory adopted by the municipalities.

Classification of the municipal territory

CLASS I – Particularly protected areas: they include areas in which quietness represents a base level for their use: hospital areas, school areas, areas destined to the rest and amusement, rural residential areas, areas of particular urban interest, public parks, etc.
CLASS II – Areas destined mostly to residential use: they include urban areas mainly interested by local vehicular traffic, with low density population, with limited presence of business activities and absence of industrial and handicraft activities.
CLASS III- Mixed areas: they include urban areas interested by local vehicular traffic or crossover, with medium density population, with presence of business activities, offices with limited presence of handicraft activities and with absence of industrial activities; rural areas interested by activities that use operating machines.

Classification of the municipal territory *(following)*

CLASS IV – Areas with intense human activity : they include urban city areas interested by intense vehicular traffic, with high density population, with high presence of business activities and offices, with presence of handicraft activities; the areas close to highways and railway lines; harbour areas, areas with limited presence of small-scale industries.
CLASS V – Prevailing industrial areas : they include areas interested by the industrial settlements and by scarcity of houses.
CLASS VI – Exclusively industrial areas : they include areas exclusively interested by industrial activities and without habitations.

The absolute limit values of immission, referred to the noise introduced in the external environment by all the sources, are indicated in the following table:

Absolute limit values of immission - Leq in dB(A)

Classes of use destination of the territory	diurnal 06÷22 hr	nocturnal 22÷06 hr
I Particularly protected areas	50	40
II Mostly residential areas	55	45
III Mixed areas	60	50
IV Areas of intense human activity	65	55
V Mostly industrial areas	70	60
VI Exclusively industrial areas	70	70

The limit values of emission, reported to the noise introduced in the external environment by a single source, are indicated in the following table:

Limit values of emission - Leq in dB(A)

Classes of use destination of the territory	diurnal 06÷22 hr	nocturnal 22÷06 hr
I Particularly protected areas	45	35
II Mostly residential areas	50	40
III Mixed areas	55	45
IV Areas of intense human activity	60	50
V Mostly industrial areas	65	55
VI Exclusively industrial areas	65	65

Differential immission limit values

The differential immission limit values, fixed by the article 2, paragraph 3, letter b), of the law n. 447 of 26 October 1995, are as follows: 5 dB for the diurnal period and 3 dB for the nocturnal period, inside house living places. Such values do not apply into areas included in the VI class of the municipal zoning.

The provisions reported into the previous paragraph do not apply to the following cases, because noise effects are deemed negligible :

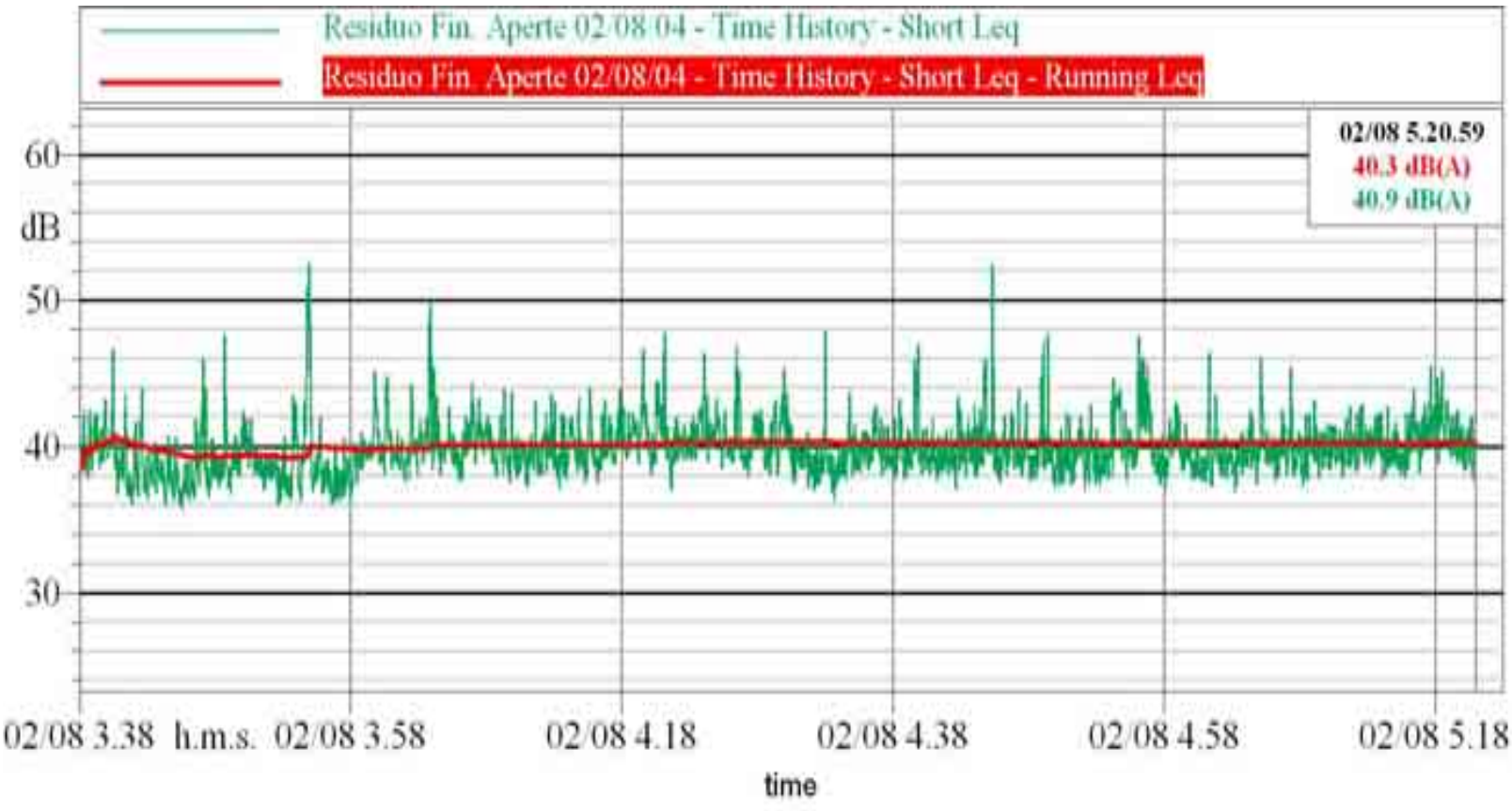
a) If the noise measured with open windows is less than 50 dB(A) during the diurnal period and 40 dB(A) during the nocturnal period;

b) If the level of the environmental noise measured with close windows is less than 35 dB(A) during the diurnal period and 25 dB(A) during the nocturnal period.

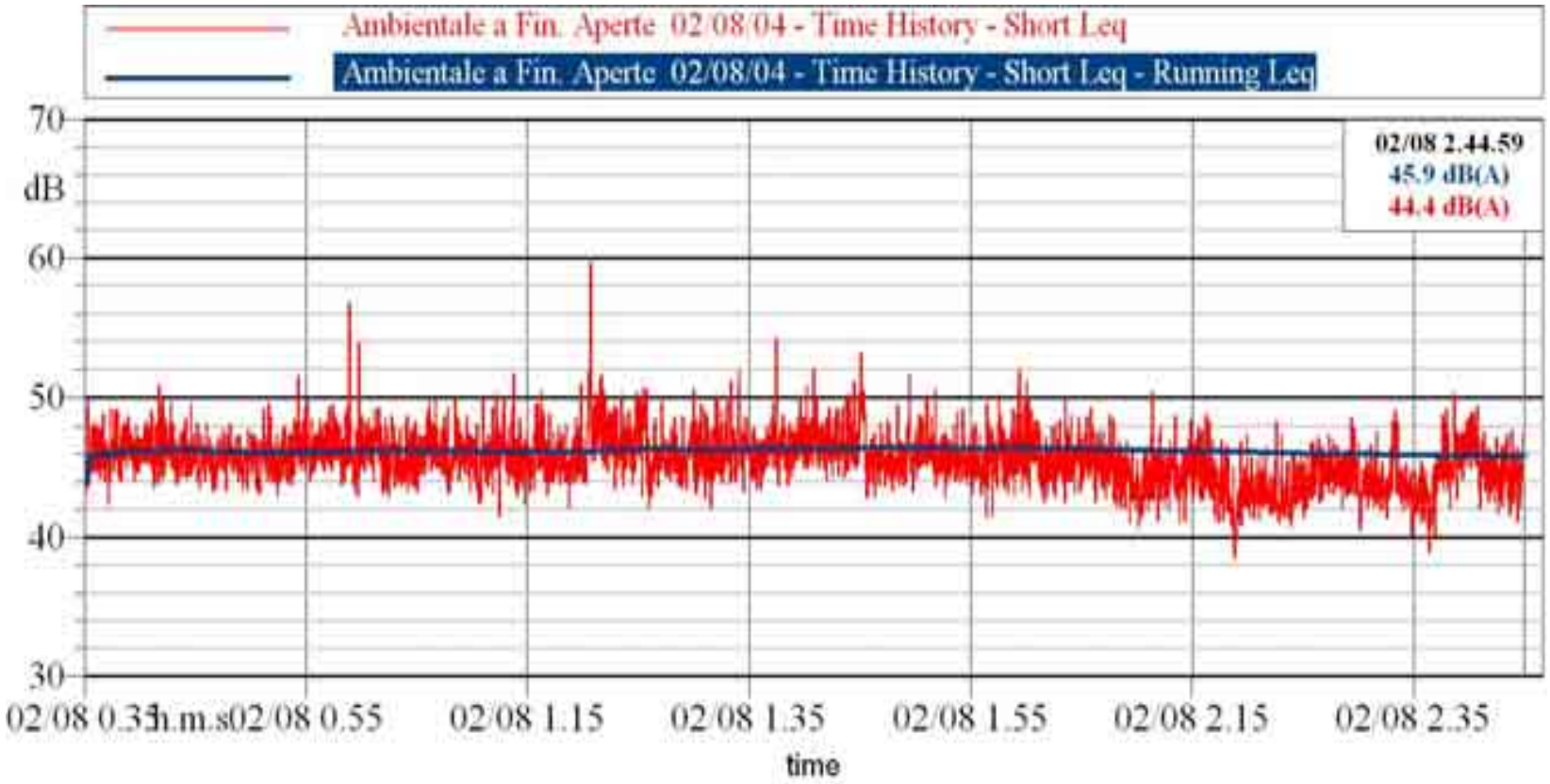
Such differential limits do not apply to the noisiness produced:

- By road, railway, airport and maritime infrastructures;
- By activities and behaviours not related to productive, business and professional requirements;
- By fixed fittings and fixtures of a commonly used building, only for disturb created inside the same one.

Example of sampling for the verification of the level of measured residual noise inside a house place with open windows



Example of sampling for the verification of the level of measured ambient noise inside a house place with open windows



Recapitulary table of the obtained results

Site	*Residual noise with open windows Leq dB(A)*	*ambient noise with open windows Leq dB(A).*	*Differential immission level Leq dB(A)*	*Limit of the differential immission level during the reference period (article 4, paragraph 1 of the DPCM 14 Nov. 1997) Leq dB(A)*
1	**40.5**	**46.0**	**+5.5**	**+ 3.0**

$$L_D = L_A - L_R = 46.0 - 40.5 = 5.5 \text{ dB(A)}$$

The limit of the differential noise level (equal to +3 dB(A)), established for the diurnal reference period (06:22 hr) has been exceeded by +2,5 dB(A).

2 – TECHNICAL NORMS FOR THE EXECUTION OF MEASUREMENTS BASED ON THE ITALIAN REGULATIONS

The measurements of the equivalent continuous «A» weighted sound pressure levels during the reference period ($\mathbf{L_{Aeq,TR}}$) can be executed :

a) By continuous integration.

The $\mathbf{L_{Aeq,TR}}$ value is obtained by measuring the ambient noise during the entire reference period, with exclusion of any anomalous conditions not representative of the zone under examination;

b) With sampling technique.

The $\mathbf{L_{Aeq,TR}}$ value is calculated as the average of values of the equivalent continuous «A» weighted sound pressure level related to the intervals of the observation time $(To)_i$.

The measurement methodology detects ($\mathbf{L_{Aeq,TR}}$) values representative of the ambient noise during the reference period, in the examined zone, of the source typology and of the sound emission propagation. The measure must be rounded off to 0.5 dB.

Positioning of the microphone

The free field microphone must be oriented towards the noise source; in the case in which the source is not locatable or they are present more sources it must be used a Random Incident Microphone.

The microphone must be installed on appropriate support and must be connected to the phonometer with a cable of length such as to permit the operators to place themselves at a distance not lower than 3 meters from the microphone.

Measurements inside house places.

The microphone of the phonometric chain must be positioned at 1.5 meters from the floor and at least 1 meter from reflecting surfaces. Detection in house places must be carried out either with open and close windows, in order to individualize the harder situation. During the measurement with open windows, the microphone must be positioned at 1 meter from the window; in the presence of stationary waves the microphone must be placed in correspondence with the peak of the sound pressure, closest to the position indicated before. During the measurement with close windows, the microphone must be positioned in the point in which the higher level of acoustic pressure is obtained.

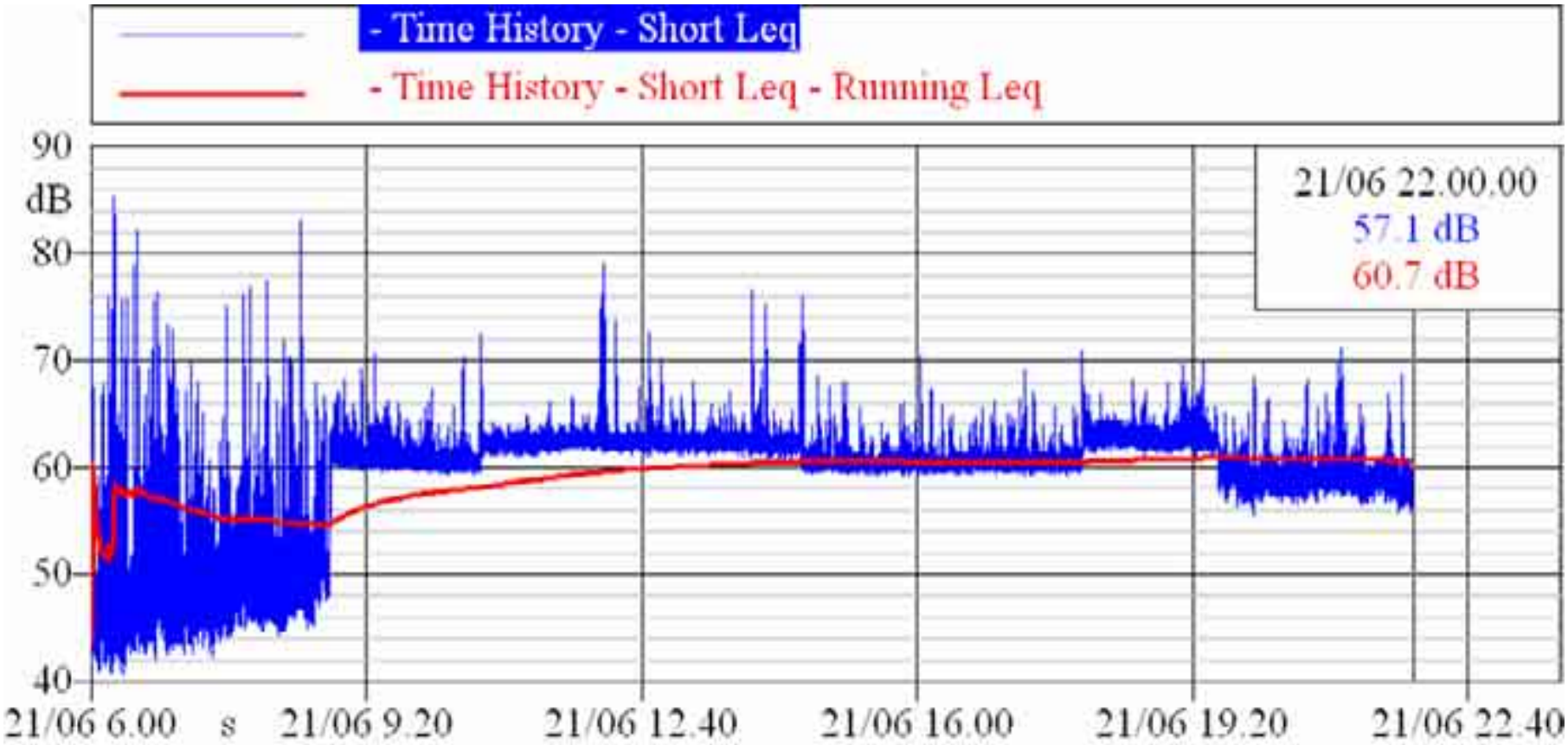
Outdoor Measurements.

In the case of buildings with façade close to the street, the microphone must be placed to 1 meter from the same façade.

In the case of buildings detached from the street or in case of open areas, the microphone must be placed inside the space usable by persons or communities and not less than 1 meter from the façade of the building, anyway. The height of the microphone for measurements either in built up areas or in other sites, must be chosen according to the effective or presumed position of the receiver.

The measurements must be executed in absence of atmospheric precipitations, of fog and/or snow; wind speed must not exceed 5 m/s. The microphone must be equipped with anti-wind cap, anyway. The measuring chain must be compatible with the meteorological conditions of the period in which the measurements are carried out and in accordance with EN Technical Standards.

Example of sampling with continuous integration (06:00-22:00 hr)
for the control of the absolute immission limits – Outdoor measurement



Instrumental detection of the event impulsiveness

For the detection of event impulsiveness, the measurements of the levels L_{AImax} and L_{ASmax} must be executed for a suitable measuring time.
Such detection can be performed contemporarily to the event or it can be executed subsequently by using the magnetic recording of the event.

Recognition of the impulsive sonorous event

The noise is considered having impulsive components when the following conditions are verified:

- the event is repetitive;
- the difference between L_{AImax} and L_{ASmax} is higher than 6 dB;
- the duration of the event, at -10 dB from the value L_{AFmax}, is lower than 1 second

The impulsive sound event is considered repetitive when it verifies at least 10 times within an hour in the diurnal period and at least 2 times within an hour in the nighttime period.

The repetitiveness must be shown through a graphic recording of the level L_{AF} performed during the measuring time T_M.

L_{AeqTR} is increased by a factor K_i

Corrective (K_i) factor: it is the correction in dB(A) introduced in order to take into account the presence of noises with impulsive, tonal or low frequency components; its values are reported in the following:

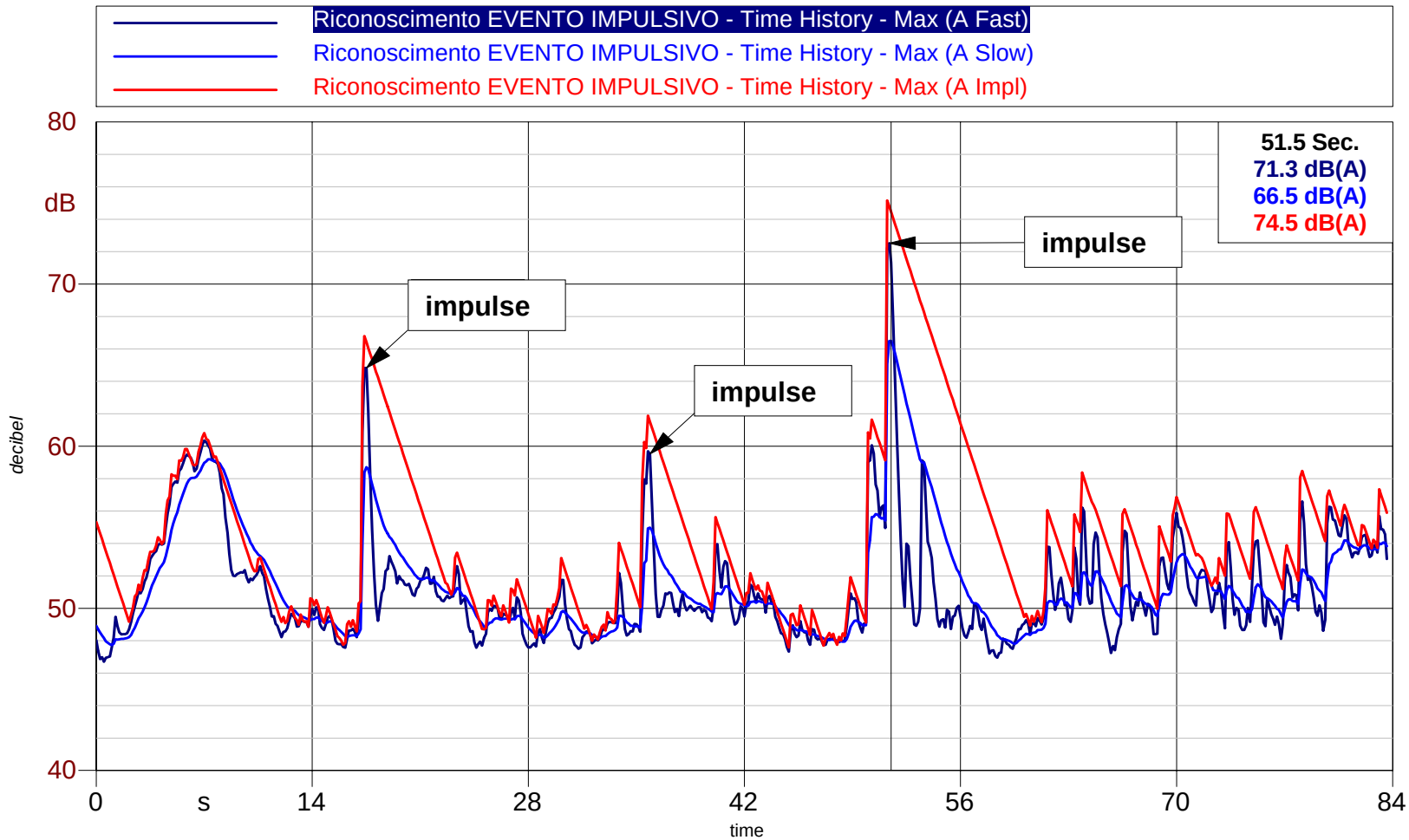
For the presence of impulsive components: .....K_I = 3 dB

For the presence of tonal components: .....K_T= 3 dB

For the presence of low frequency components.....K_B=3 dB

The correction factors do not apply to transports infrastructures.

Example of recognition of impulsive event



Recognition of tonal components of noise

In order to individuate the presence of Tonal Components (TCs) in the noise, a spectral analysis for normalized bands of 1/3 of octave is performed. TCs having static character in time and in frequency are exclusively considered.

If sequential filters are used, the minimal of each band with time constant Fast is determined.

If parallel filters are used, the level of the stationary spectrum is underlined by the minimal level in each band.

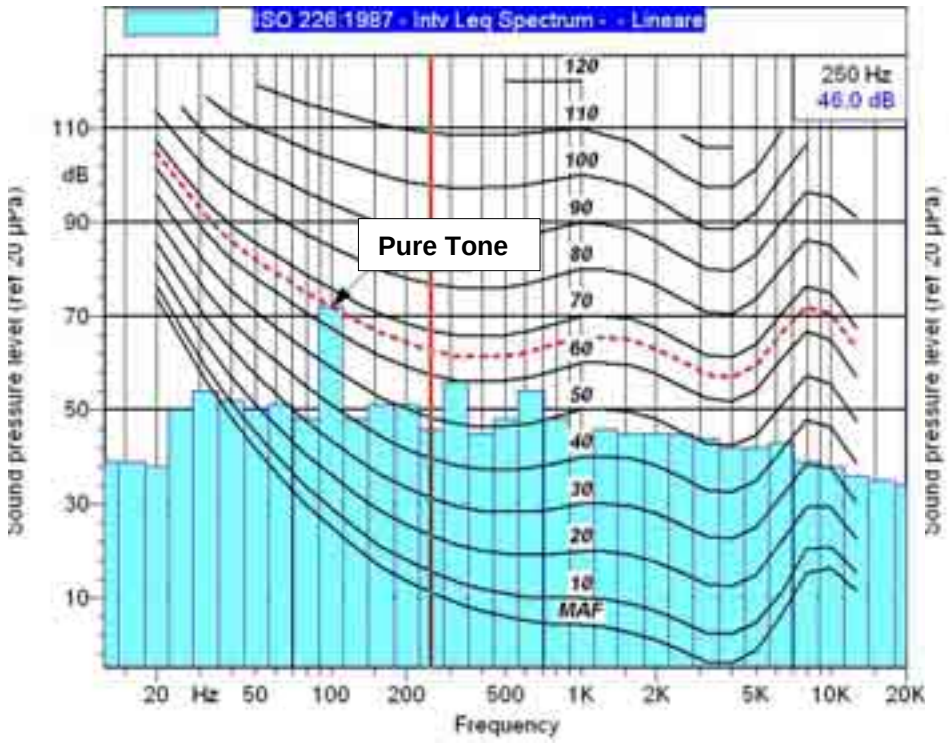
In order to underline the TCs that correspond to the intersection frequency of two 1/3 of octave filters, the latter can be used with a greater selective power or alternative intersection frequencies.
The analysis must be conducted in the interval of frequency between 20 Hz and 20 kHz.

If the minimal level of a band overcomes the minimal levels of the adjacent bands at least of 5 dB, it rappresents the presence of a TC . The correction factor $\mathbf{K_T}$, as defined into point 15 of Annex A, is applied only if the TC touches an isophonic equal or superior to the most elevated isophonic reached by the other components of the spectrum.
The Italian reference technical norm is the ISO 226:1987 (this norm has been modified by the equivalent norm ISO 226:2003).

Differences among ISO 226 curves of equal sound perception

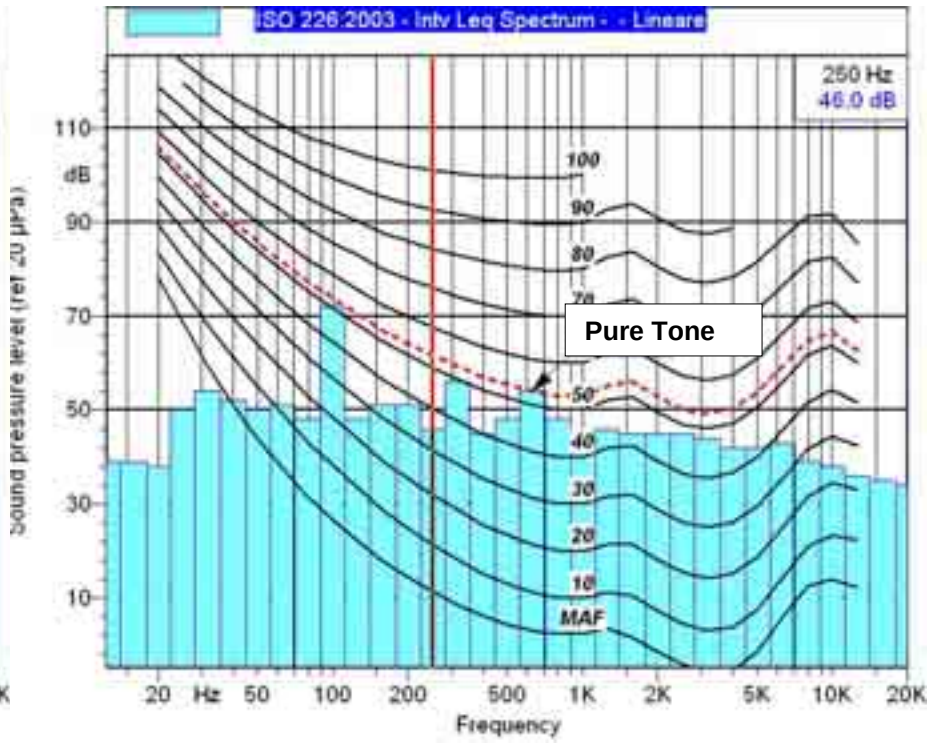
ISO 226:1987

Pure Tone et 100 Hz



ISO 226:2003

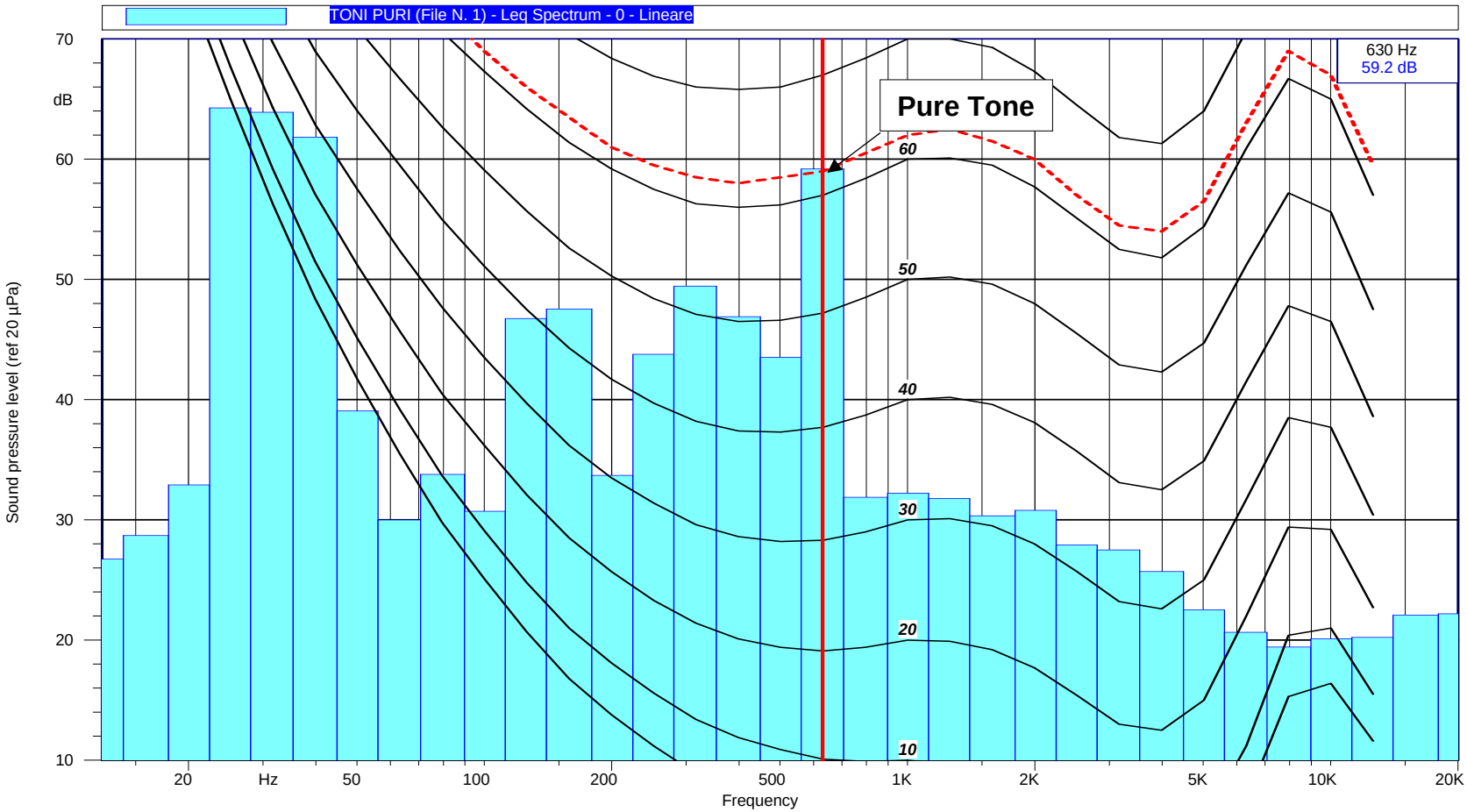
Pure Tone et 630 Hz



Presence of low frequency spectral components

If the analysis in frequency, executed according to the formalities noticed into the preceding point, points out the presence of TCs such to allow the application of the corrective factor $\mathbf{K_T}$ in the interval of frequencies between 20 Hz and 200 Hz, the correction $\mathbf{K_B}$, as defined into the point 15 of the Annex A, is also applied exclusively in the nocturnal reference time.

Example of recognition of a pure tone corresponding to 630 Hz

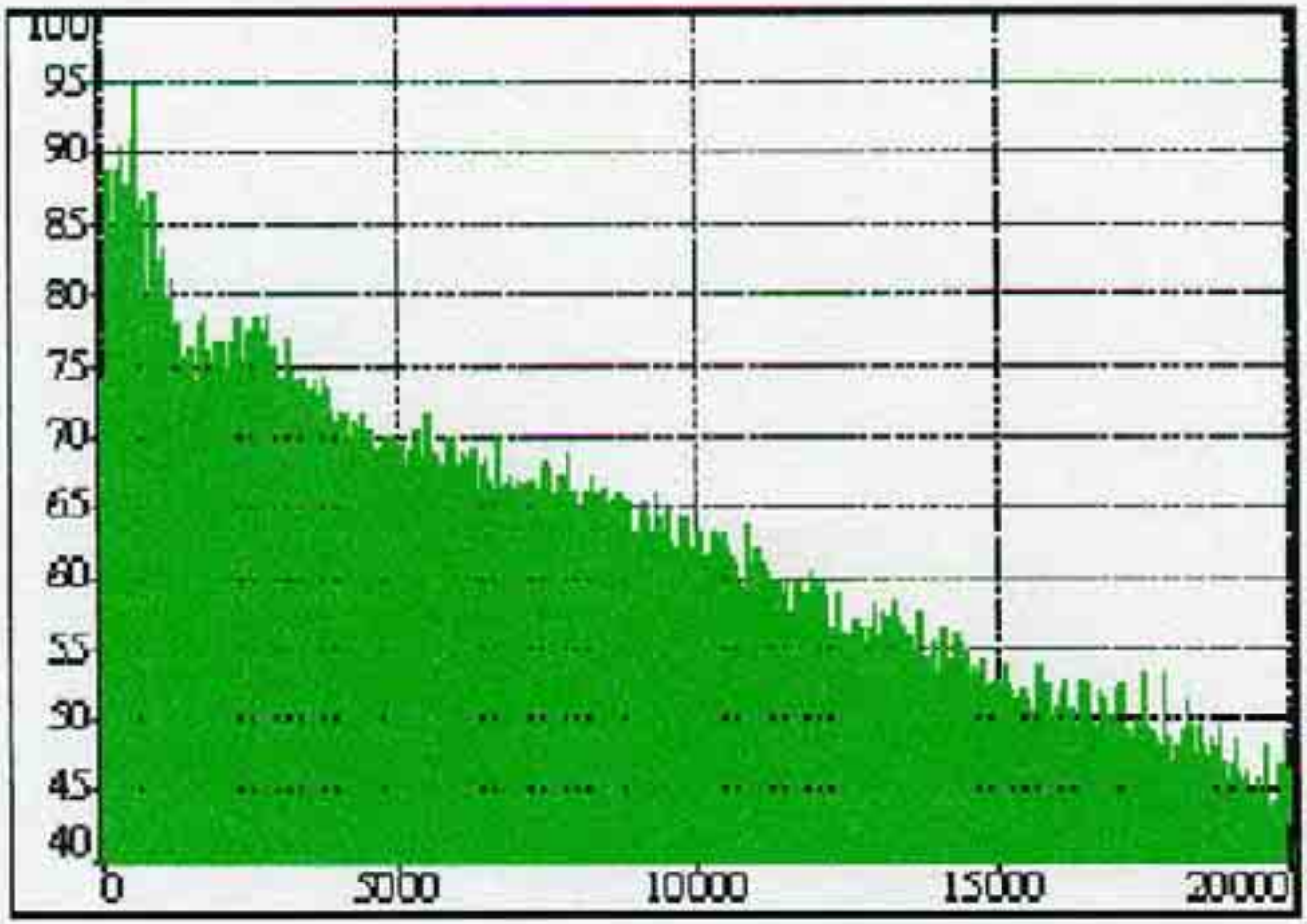


Whenever it is necessary to know with extreme precision the frequency of a particular tonal component (TC) (for instance in laboratory for the improvement of a device or for the solution of a problem), it is possible to perform a more selective analysis in frequency, for instance like the Fast Fourier Transform (FFT).

In this case it is possible to get resolutions in the order of fractions of Hertz, with the purpose to discriminate phenomena that are introduced to very close frequencies.

The resultant spectrum will be represented on a linear x-axis reporting the frequencies, in which every line FFT will be singly represented; some analyzers represent continuous spectra instead of lines, but this is only a graphic choice.

Example of FFT representation



Partial time noise is considered only during the daytime in the event the noise persists for a total time no longer than an hour.

If partial time noise is comprised between 1h and 15 minutes the value of the ambient noise, measured in Leq (A), must be diminished of 3 dB(A); if it is lower than 15 minutes the Leq (A) must be diminished of 5 dB(A).

For sonorous emissions coming from alarm systems, the limits of the present Decree are not applied, but the duration of this type of emission cannot exceed the period of 15 minutes.

3 – References of Italian regulations

- Law n. 447 of 26 October 1995,– *"General policy law on acoustic pollution ";*
- Decree of the President of Cabinet 1 March 1991 *"Maximum limits of exposure to the noise into house places";*
- Decree of the Ministry of the Environment 11 December 1996 - "*Application of the differential criterion for the fittings based on continuous productive cycle*";
- Decree of the President of Cabinet 14 November 1997 "*Determination of the limit values of sound sources*";
- Decree of the Ministry of the Environment 16 March 1998 - *"Techniques of survey and measurement of the acoustic pollution".*