AIR COMPENSATION EQ TOOL

TECHNICAL BULLETIN

VERSION 1.0

INTRODUCTION

In long throw application, high frequencies propagation can be strongly affected by air absorption. Compensation of this phenomenon can be addressed thanks to the *Air Compensation* EQ tool.

This EQ tool is included in LA Network Manager (from V2.2.0.0), remote control software for LA amplified controller's network, and can be modeled in SOUNDVISION (from V2.2.4), software for 3D acoustic simulation of L-ACOUSTICS systems.

This tool has been specially designed to allow for a simple yet efficient use, providing a single gain setting which controls the shape of a linear-phase FIR filter.

It allows re-establishing the original frequency response of loudspeaker enclosures, up to a limit dictated by the need to preserve a maximum of the driver resources.

PHYSICAL PHENOMENON

For given atmospheric conditions, sound attenuation at a specific frequency increases linearly over distance. It can therefore be defined by an attenuation coefficient, in decibels per distance unit. The atmospheric absorption over a given range of frequencies is then described by a set of attenuation coefficients.

For any atmospheric conditions, it can be observed that the greater the frequency, the greater the attenuation. But the effect of atmospheric variables is not linear, so that a distinct set of attenuation coefficients has to be given for each different combination of temperature (T) and humidity (H).

Two important trends can be extracted:

- Air absorption is critical for high frequencies at long distances.
- Attenuation decreases when humidity increases for most of atmosphere conditions over 10°C and 10% humidity.

In figure 1, attenuation coefficients are illustrated for various combination of atmospheric variables (0°C to 40°C, from 3% to 80% of humidity), through the values defined by ISO 9613-1-1993. The attenuation curve for T=20°C and H=40% is indicated as a reference.

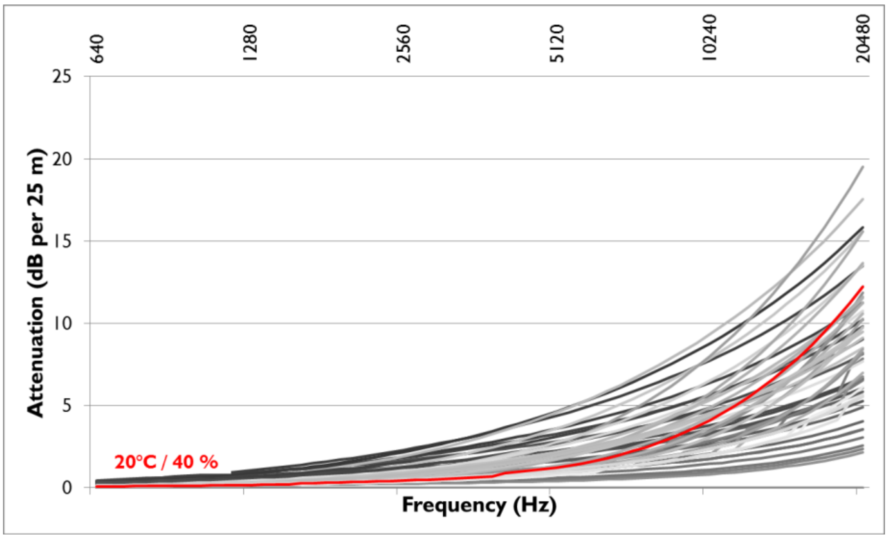


Figure 1. Attenuation curves for various combination of temperature and humidity

DSP SOLUTION

EQ Filter shape

The *Air Compensation* EQ tool is based on linear-phase FIR filters, allowing its use on line source elements without disturbing the wave-front coherency.

In figure 2, all the possible the filters generated by the *Air Compensation* EQ tool are represented. Observing the general shape, two main zones can be identified.

- First zone is an increasing slope dedicated to HF compensation. Its shape is derived from ISO 9613-1-1993.
- Second zone is a descending slope designed to preserve the resources of the HF driver.

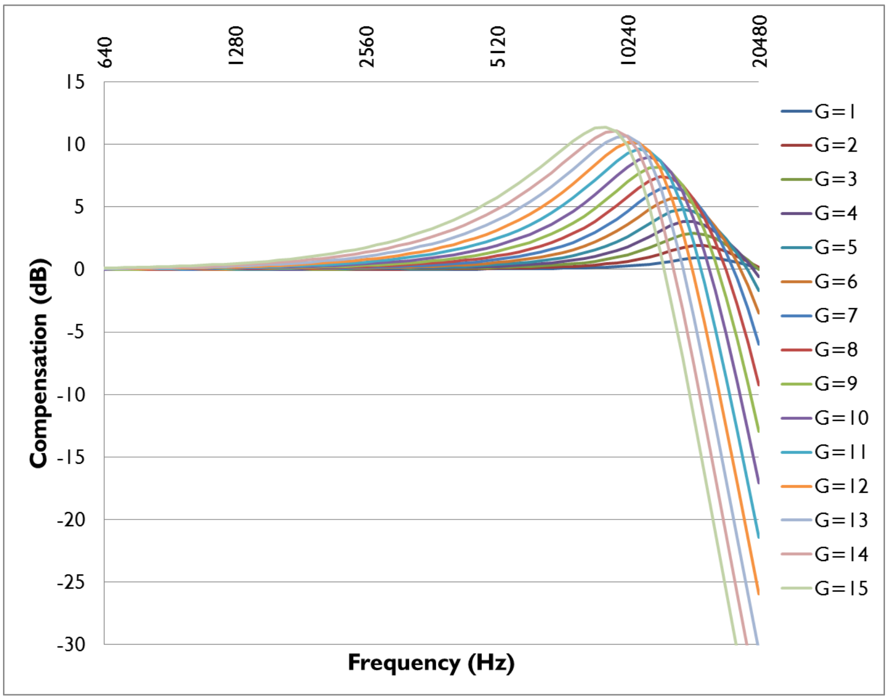


Figure 2. Compensation curves for each different G value of the *Air Compensation* EQ tool

The result is a filter that counter-balances level attenuation for frequencies as high as possible without putting the driver integrity at risk. The range of high frequencies for which the level is not totally re-established is:

- Barely audible for most of the audience (*considering a normal middle age adult can only hear up to 15 kHz);*
- Hard to master (*due to other environmental factors such as wind or temperature gradients*);
- A lost cause (*observing for example that nearly 50dB are lost at100m at 20 kHz for T=20°C and H=40%*).

A single parameter

L-ACOUSTICS wanted the tool to be simple to use. Observing that different combinations of distance, humidity and temperature could result in the same filter shape, L-ACOUSTICS established a single magnitude parameter G whose values cover most of operating conditions.

The different G values represented in Figure 2 can be considered from two distinct perspectives:

1. At a same distance, different values corresponds to different temperature/humidity combinations

   Example: at 50 m, G=7 may compensate for T=5°C H=3% and G=12 for T=20°C H=80%

2. For a same temperature/humidity combination, increasing values corresponds to increasing distance

   Example: for T=20°C H=40%, G=10 may compensate at 50m and G=15 at 150 m

As a result, if experience and knowledge of the atmospheric variables could allow anticipating the setting of *Air Compensation*, the tool has be designed so that it can be easily fit to acoustic results (on site measurement or simulation) by trial and error of a single parameter. The recommended procedure is explained below.

USING THE EQ TOOL

It is likely that the *Air Compensation* has to be applied differently for distinct groups of line source elements, according to the respective distance they target. Remember that attenuation is the most critical at long distances and, therefore, *Air Compensation* EQ should address the top elements of a line in priority.

Air Compensation allows covering most of operating conditions (from 0°C to 40°C, from 3% to 80% of humidity).
However, the maximum distance to which it compensate level attenuation is highly dependent on atmospheric conditions (as a reference, up to 150 m for T=20°C /H=40%).

In LA Network Manager (from V2.2.0.0)

Air Compensation is a group parameter in the *Contour EQ* interface of LA Network Manager software, and can therefore be applied to a group of amplified controllers or a group of output channels. However, one Air absorption EQ only can be used on a specific output channel. As a result, if several different Air Absorption equalizations are to be used, they can only be applied to distinct groups of output channels.

In SOUNDVISION (from V2.2.4)

Temperature and humidity values can be set in SOUNDVISION options, in order to simulate air absorption. By selecting array elements in the *Contour EQ* toolbox of SOUNDVISION, one can enter a G value for *Air Compensation*. However, it should be reminded that actual atmospheric conditions on site may be quite different from what is expected. Moreover, they are likely to vary over the course of the day, from the system calibration to the show, as well as over the course of the show. Therefore, SOUNDVISION can give a good starting point for the G values, but the results should be checked on-site by observing measurements.

Procedure

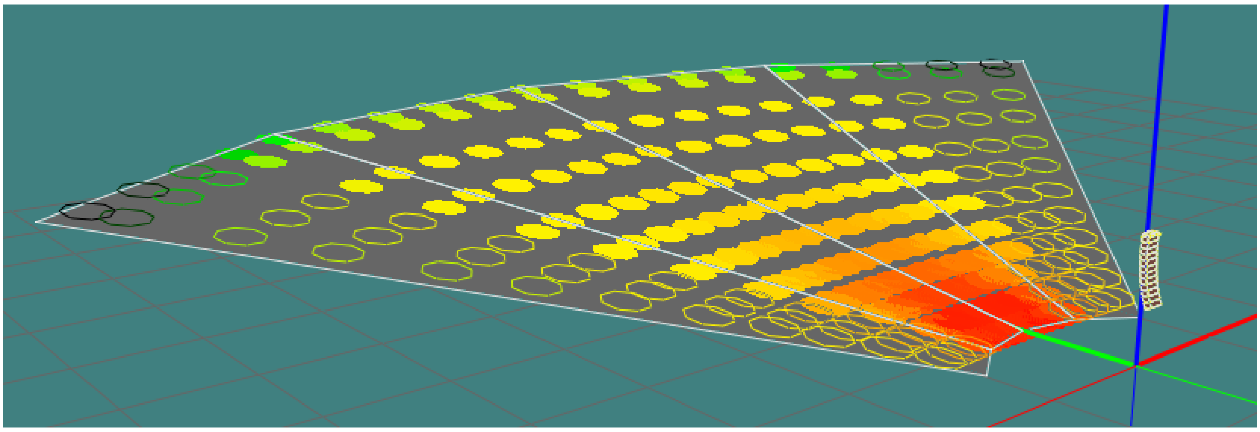
1. Measure or simulate the frequency response curve at a reference distance from the source.

2. By observing the effect of G, determine the reference value that allows getting close to the desired frequency response.

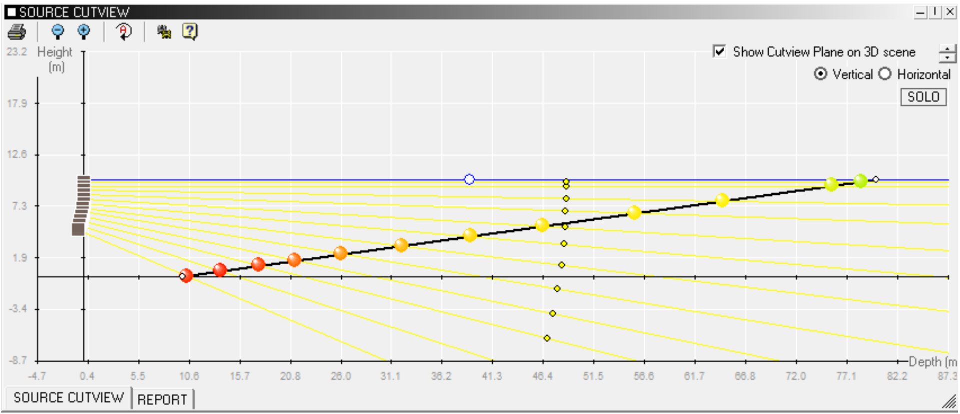
NOTE:
If other elements targeting other distances are to be compensated, G adjustment will generally correspond to distance variation: increase G for longer distance or decrease G for shorter distance.

APPLICATION EXAMPLE

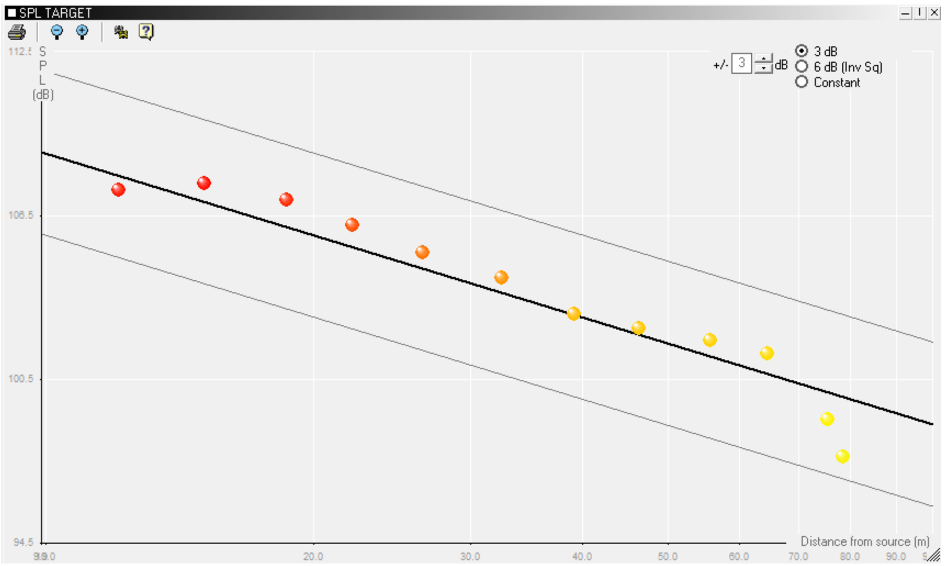
0. A line source composed of 12 K1 has been modeled in SOUNDVISION with *Air Absorption Calculation* turned off.



3D Scene *window: full audience geometry with 1-10 kHz impact points on the horizontal and vertical dimensions.*



2D cutview *toolbox: 1-10 kHz impact point of each element on the vertical dimension*

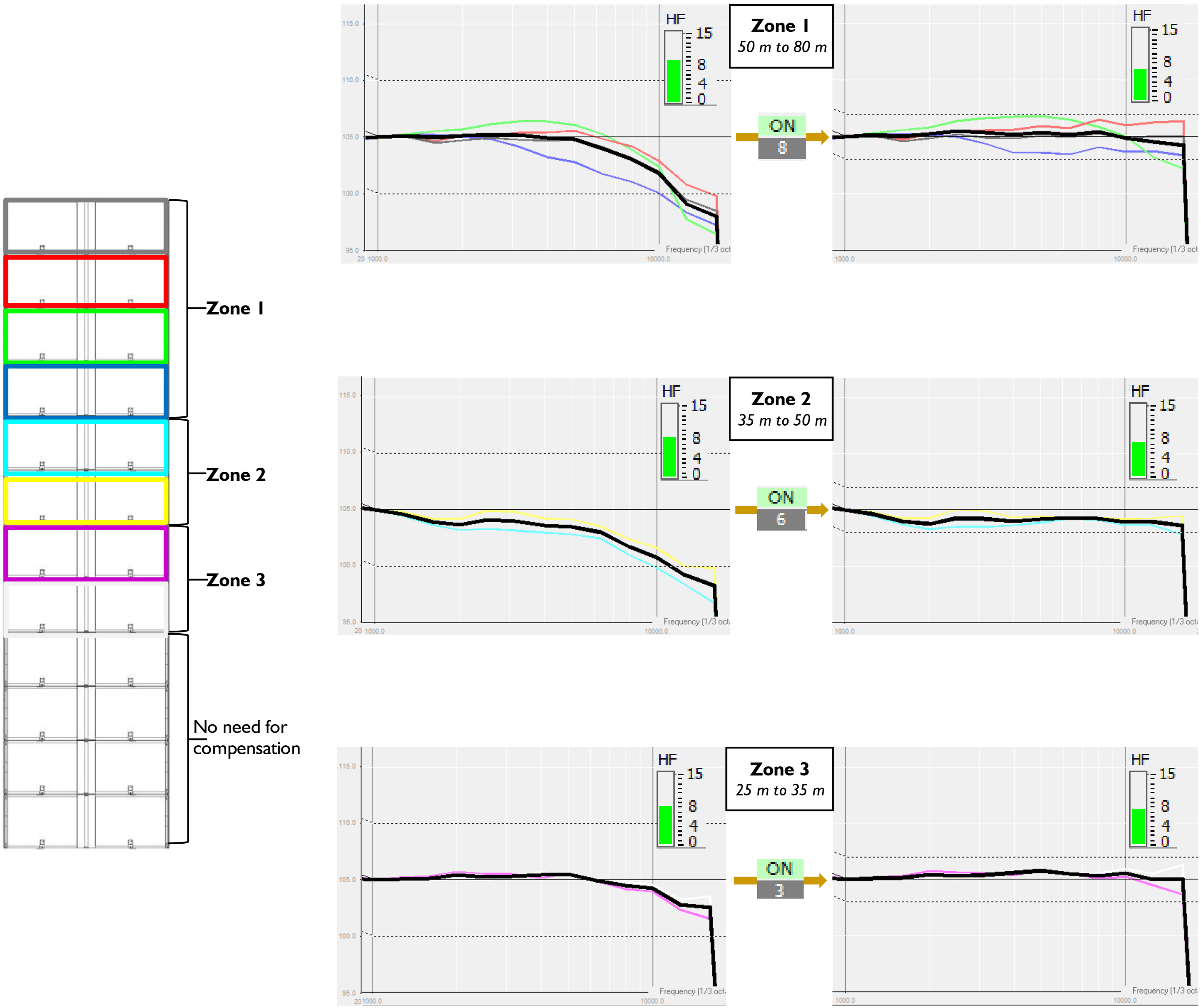


SPL target *toolbox: 1-10 kHz SPL decrease of -3dB per doubling of distance*

***Air Absorption Calculation* is turned on, with H=50% and T= 20°C**.

After having used FIR filters to EQ the frequency responses in the mid-range, one wants to compensate for HF attenuation.

1. By observing the response curves, groups of loudspeaker enclosures with similar HF attenuation are identified.
2. The *Air Compensation* EQ tool is turned on and the best G values are determined.



***Response curves** normalized at 105 dB/1000 Hz*

With mean average in black and HF resources indicator

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