

Advice to avoid hearing damage and violation of SPL-limits

What can be done to lower the SPL? Here is a list of suggestions:

- *Apply acoustic treatment to the venue - take care of unwanted reflections and resonances*
- *Ensure even coverage of the loudspeaker system*
 - *Use Line Source Arrays*
 - *Install distributed delay systems*
 - *Directive loudspeakers*
- *Install barriers to prevent the audience from being too close to the loudspeakers*
- *Plan the show or event in order to optimise the “Leq budget”, i.e., don’t run the show too loud at the start so that you have some SPL margin left for highlights during the show and the grand finale at the end*
- *Improve audience circulation in order to minimize their exposure*
- *Electronic compression/limiting of the signal that is applied to power amplifiers and loudspeakers*
- *Adding distortion to the sound at high levels*
- *Avoid peaks in the frequency response around 2 and 8 kHz*

If there is a live performance more can be done:

- *Improve the on-stage acoustics to improve the separation of PA and stage sound*
- *Reduce resonances of the stage floor*
- *Place an acoustic screen (plexiglass) in front of the drum kit and brass section*
- *Control the coverage and level of the stage monitoring loudspeakers*
- *Use In-Ear Monitoring to reduce stage volume*
- *Control the coverage and level of the backline loudspeakers (guitar amplifiers etc)*

Bear in mind that the SPL shall be measured at the worst case location that the audience has access to - not at mix position (SPL can be measured at mix position but the value must be corrected by determining the difference between the value at the mix position versus the worst case location). This means that the SPL has to be measured at several positions throughout the audience to determine the worst-case location. For live performances, this is normally close to the stage where the backline (for example, guitar amplifiers on stage), stage monitors, drums and the PA system all act together.

Note: This is a two-page appetiser of a 14 pages paper included in the RT-Capture documentation.

Planning the sound level during the event

Keep the dose of SPL down:

Most guidelines recommend a sound dose of around 100 dBA Leq [1]. This is usually over a limited time, 2 – 4 hours.

If the audience is seated during the entire performance it is relatively straightforward to ensure that the dose is not exceeded - simply by measuring the Leq at the worst case position where the audience is seated.

If the audience is moving around like in a club or at a festival, it is more difficult to determine the dose. Lets say that an individual spends one hour in front of the stage and has been exposed to 98 dBA Leq. After that, he/she spends one hour in a bar where the Leq is only 88 dBA. The person will then have a total Leq of around 96 dBA for the entire two hours.

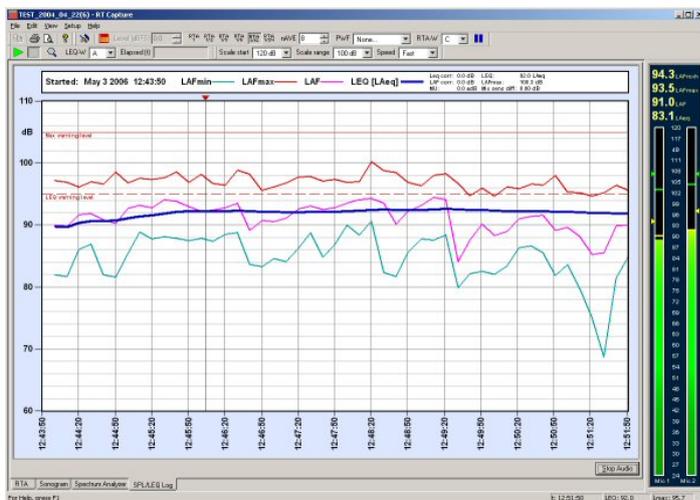
If the Leq difference is more than 20 dB then the quieter place will not contribute to the Leq. For the example above, if the individual spends 1 hour in a bar where the Leq is 76 dBA, the total Leq for two hours will be 95 dBA (i.e., -3 dB).

Providing a quiet bar also provides a few extra dB in the Leq budget.

Note: This extra budget is **only for the Leq**. The peak SPL (LCpeak) or max instantaneous SPL (LAFmax) will of course have the same maximum recommended value. These values will not be influenced by the exposure time [2].

How to keep within the Leq budget?

RT-Capture log window



The peak or max SPL can be controlled electronically with compressor/limiters and/or careful selection of the power amplifier and loudspeaker. To manage the equivalent continuous SPL dose (Leq) is much harder and it's recommended that you try to consider Leq as a budget that can't be exceeded, i.e., by planning the performance and analysing the set list so that high SPL parts in the show are taken into consideration, the sound engineer can plan the SPL level for

each song in the set. A big help is to have a graphical log of the SPL and Leq of earlier performances or rehearsals (see RT-Capture log). If the SPL-log is combined with a sound recording that is synchronised with the log, the sound engineer will have a useful tool to create a Leq budget.

Remember that most guidelines state that the exposure is linked to a time period of 2–4 hours. According to this, measurements shall be made during the entire performance including breaks. However, the nature of the Leq calculation means that quiet breaks - even if they are up to half the time of the overall performance – will only reduce the Leq by 3 dB.

[1] WHO: Occupational and community noise, Fact sheet N°258, Revised February 2001, <http://www.who.int/mediacentre/factsheets/fs258/en/print.html>

[2] Gustafson: SP INFO 2004:45, www.sp.se/energy/acoustics/sv/publikationer.htm