



### **B23 Optimal Distance Determination for Reference Recordings Using Reference Subtraction Filtering in Noisy Environments**

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After attending this presentation, attendees will understand the importance of reference subtraction filters using reference recordings made simultaneously with targeted conversation recordings in noisy environments, such as restaurants, coffee shops, or bars, to determine optimal distance from the recording reference to the target to optimize the filter's response.

This presentation will impact the forensic science community by serving as a best practice or standard when making a covert recording of a subject in noisy environments.

Reference subtraction filters work by performing a continuous and intelligent subtraction of one audio signal from another. Normally, with a forensic recording containing speech masked by loud audio, one would require a reference recording containing just the audio that needs to be removed. The audio track containing the music or other audio to be removed is called the "Reference Track." This type of filtering has had great results in a real-time reference capturing environment. It is done by placing two microphones in the area of the target conversation. One is placed near the target conversation, and the other near the source of the background noise or audio source such as a TV, stereo system, jukebox, or a live band. Then, using a reference subtraction filter that can operate in a live situation, the reference noise signal can be subtracted from the source to produce a more intelligible target conversation. These types of two-microphone, live recordings take a lot of coordination and are usually done when a hotel room is used for the targeted conversation. There is a need to use reference subtraction type filtering in a post-processing environment.

To make reference subtraction filtering effective in a noisy multi-signal environment, two separate recordings need to be made simultaneously. Making a reference recording at some distance from a targeted recording in a noisy background environment will aid in decreasing the noisy background. The key variable is determining the optimal distance that a reference recording should be made from the targeted recording in the same noisy environment, and then use a reference subtraction filter to make the targeted conversation more intelligible.

A series of reference and source recordings will be made in different noisy environments (e.g., restaurants, coffee shops, or bars). The source recording will be made to simulate a covert recording of a suspect while in the noisy environment. The reference recording will be made simultaneously to the target recording in the same environment, but at different distances, in an attempt to eliminate the noisy environment from the target. The filtering will be done with several popular reference subtraction filters made by different audio forensic processing systems.

Real-time and post-reference subtraction filters are widely used and have been proven effective in reference subtraction of a single sound source broadcast television show or music recording. What about reference subtraction in multiple sound source situations such as restaurants, bars, or coffee shops? In many covert law enforcement targeted conversation recordings taking place in these noisy environments, tests will be done to determine the optimal distance to make a reference recording that would subtract the noisy background most effectively. Test recordings will be produced in several different noisy environments using the same type of recorders and microphones with the only variable being the distance from the source recording. The improvement in intelligibility will be reviewed aurally, spectrographically, and with signal-to-noise ratio measurements.

**Audio, Enhancement, Multimedia Forensics**