The ER-33 Occlusion Effect Meter quickly quantifies the occlusion effect and earmold leakage. This information can reduce the need for remakes and reduce the need for factory help with adjusting or reprogramming hearing aids.

- **Portable, hand-held**
- **Quick**
- **Makes troubleshooting easier**
- **Doesn't require real ear equipment**
- **Identifies source of feedback**
- **Determines how much venting reduces occlusion**
- **Reduces remakes**
- **Improves communication between clinicians and manufacturers**

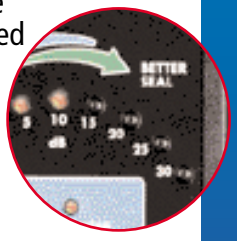
OCCLUSION EFFECT METER

Who Benefits?

- **Hearing professionals**
  Better identification of patient complaints(e.g. hollow voice, muffled sound, unnatural sound quality, feedback)
- **Hearing instrument users**
  Quicker solutions to problems, fewer visits and fewer remakes
- **Musicians Earplug users**
  Less occlusion effect when playing brass and woodwind instruments or singing
- **Manufacturers**
  Fewer remakes and less need for dispenser support with adjustments and programming

The ER-33 Occlusion Effect Meter contains two sound level meters that detect and filter acoustic signals. Two microphones separately measure the SPL inside the earcanal and outside the ear. The ER-33 measures the amount of occlusion effect in dB SPL or seal integrity (amount of earmold leakage) in dB SPL.

In **Occlusion Effect mode**, the smaller the difference between the SPL inside and outside the ear, the less the occlusion effect.



In **Seal Integrity mode**, the greater the SPL difference between an outside sound and the sound measured inside the earcanal, the better the seal. When the sound generated by an outside source (e.g. the examiner's voice) is nearly the same as the sound measured inside the earcanal, there is excessive earmold leakage.

Most common complaints of Occlusion Effect

- Person's own voice sounds "hollow" or "boomy"
- Sounds are muffled
- Ears or hearing seem blocked or plugged
- Unnatural or poor sound quality of hearing instruments

Sources of Occlusion Effect

- Eartip is too short on finished mold (shallow seal)
- Eartip is long but does not seal deeply in the earcanal
- Inadequate venting
- Poor impression
- Good impression but finished mold does not fit well

Sources of earmold leakage/feedback

- Poor seal
- Too much venting
- Poor impression
- Good impression but finished mold does not fit well

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OCCLUSION EFFECT

The occlusion effect is caused by sound transmission into the earcanal from vibration of the cartilaginous portion of the earcanal wall when the ear is occluded (e.g. by earmolds or hearing aids). The occlusion effect is a low-frequency phenomenon, occurring mostly below 500 Hz.

The occlusion effect is most commonly caused by vibration from a person's own voice (speaking or singing), chewing, or from a musical instrument (brass, woodwinds). The vibration comes from the sound pressure level developed in the back of the mouth, which can be as high as 140 dB SPL when the closed vowel "ee" is produced. Complaints of "there's an echo in my voice," "my voice sounds hollow," or "it sounds like I'm talking in a barrel" are common. The occlusion effect does not occur in an open (unoccluded) ear canal.

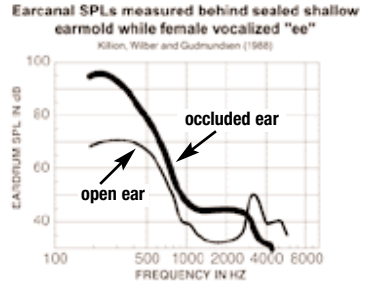

Figure 1

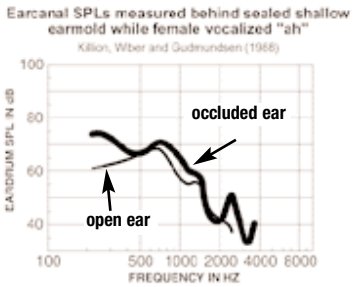

Figure 2

Figure 1 shows the difference between the earcanal SPL developed by a closed vowel "ee" in an open ear and an occluded ear. Note the 25 dB difference at 200 Hz and 12 dB difference at 500 Hz. Figure 2 shows a much smaller difference in earcanal SPL at 200 Hz for the open vowel "ah." (When "ah" is produced, the sound pressure level in the back of the mouth drops to about 115 dB SPL.)

Note: A good way to demonstrate the occlusion effect is to simultaneously push on the tragus of each ear while humming, vocalizing "ee" or chewing. There is an increase in loudness which makes the sound appear to be mostly in the head.

The Effects of Venting

Venting lets out the low frequency energy produced by the occlusion effect. Figures 3 and 4 illustrate the effect of various vents in two earmolds. The earmold in Figure 3 seals near the entrance of the earcanal, producing more than 30 dB of occlusion effect. Doubling the vent diameter lets out enough low frequency sound to reduce the occlusion effect about 12 dB, but it also lets out enough high frequency sound to increase the likelihood of feedback by about 12 dB. As a result, it is sometimes impossible to solve the occlusion effect with venting before feedback becomes unacceptable.

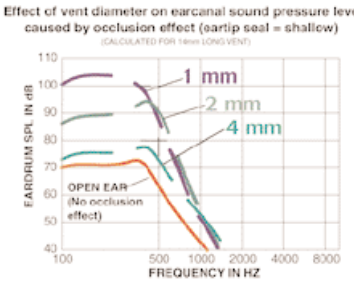

Figure 3

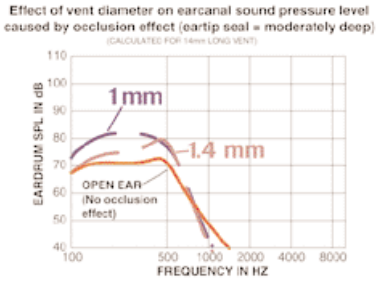

Figure 4

The earmold in Figure 4 seals fairly deeply, producing only about 10 dB of occlusion effect. In this case, the SPL from the occlusion effect is small and requires only a small vent to solve the complaint.

Shallow vs Deep Insertion

The occlusion effect commonly occurs when there is a shallow insertion of an earmold or hearing aid. Numerous studies have confirmed that if a mold seals at or beyond the second bend (in the bony portion) of the earcanal, vibration decreases significantly, which reduces or eliminates the occlusion effect.

With a shallowly sealed earmold, the occlusion effect will typically be quite large. It will often not be possible to use enough venting to adequately reduce the occlusion effect without causing feedback.

By using a deeply sealed eartip, the occlusion effect is minimized as shown by Killion et al.[4] (1988) and more recently by Pirzanski (1998);[11] see Figures 5 and 6. When feedback is the primary concern, a deeply sealed earmold provides a bonus beyond reducing the occlusion effect, because: a) the rigidity of the earcanal in the bony part tends to immobilize the earmold, which further reduces the tendency to feed back, and b) the bony part is not subject to changes in the shape of the earcanal. Tens of thousands of owners of high-gain hearing aids and Musicians Earplugs wear deeply sealed soft earmolds comfortably. This construction is the first choice for any BTE wearer who needs high gain.

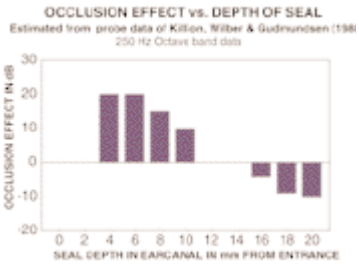

Figure 5

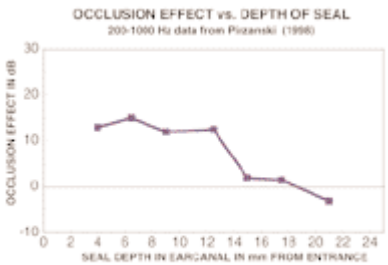

Figure 6

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G. Gudmundsen