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Does ISO 9613-2 Apply to Shooting Sound?

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Overview

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  - Source Dependence of Divergence
  - Sound Field Absorption Instead of Wave Absorption
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Introduction

- ⇨ At present, a joint working group (JWG51) is working on the standard ISO 17201 that shall provide methods
  - to describe the source strength of the muzzle blast (part 1)
  - to estimate the source strength parameters (part 2)
  - to predict the effects of propagation phenomena (part 3)
  - to consider the projectile sound (part 4)
  - to assess shooting noise (part 5)

Can we simply adopt the methods of ISO 9613 in part 3 ?

- ⇨ *No Question*: ISO 9613-2 describes a widely accepted procedure to predict noise receiver levels from continuous sound sources.
- ⇨ *However*: ISO 9613-2 excludes in its scope the application for shooting sounds. ***Why?***
- ⇨ *Missing*: There is no other recommended method to describe the propagation for shooting sounds and predict noise levels.
- ⇨ *Nevertheless*: (For example German) Authorities prescribe the use of ISO 9613-2 to predict and assess the noise from small arms.

Energy versus Power

Power ISO 9613-2	**Energy** ISO 17201
⇨ Energy per time period in Watts to describe the source ⇨ Intensity in Watts per square meters to calculate receiver levels	⇨ Energy per event in Joules to describe the source ⇨ Energy density in Joules per square meters to calculate receiver levels

Do the concepts of 9613-2 hold also for event energy to describe the source strength?

Frequency and especially time weighting needs to be considered.

For single events, for example, the evaluation of ‚FAST'-levels depends on the time gap at the receiver between signals that propagate along different paths to the receiver.

Introduction of additional rules to evaluate weighted levels ?

Height of Burst I

From ISO Draft Technical Specification 13474:
"Acoustics – Impulse sound propagation for environmental noise assessment"

Height of burst gain:

The gain G_{HOB} in decibels to convert the sound exposure of an open air burst to that of high energy reflection from the ground ...

$$G_{HOB} = 10\lg(F)\ dB$$

A_{hob} a new and additional source level correction ?

Height of Burst II

Formulae

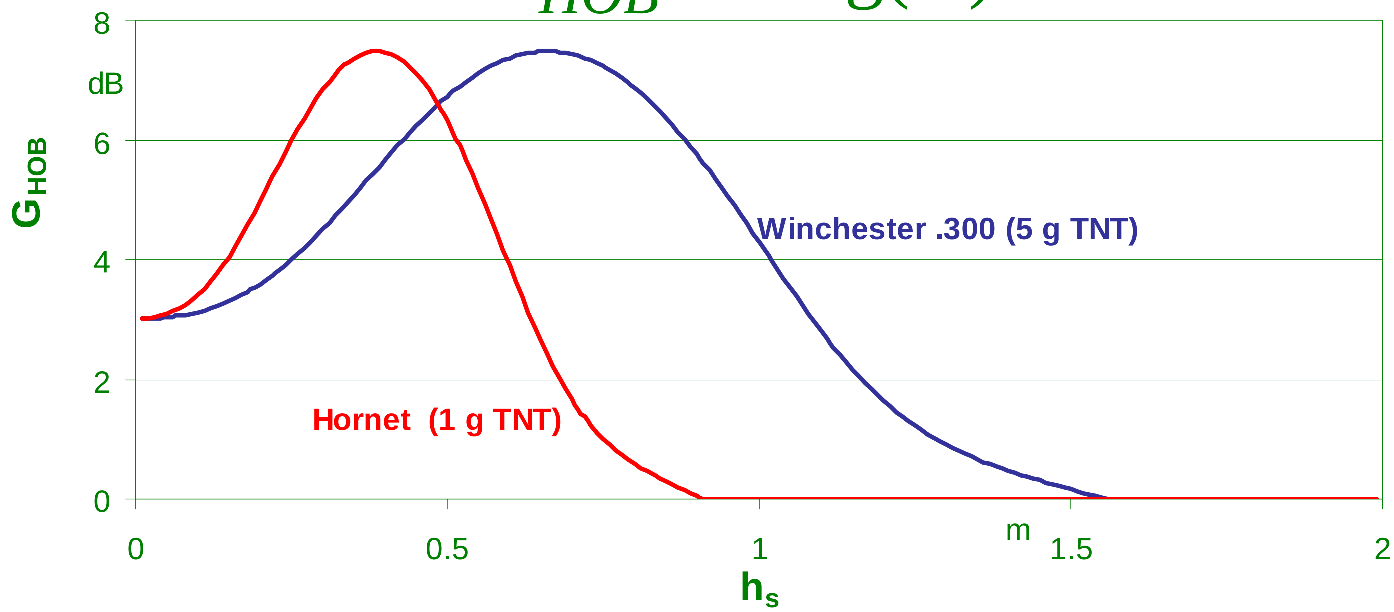
$$h'_s = \frac{h_s}{\sqrt[3]{Q}}$$

h_s height above ground [m]

Q mass of equivalent TNT [kg]

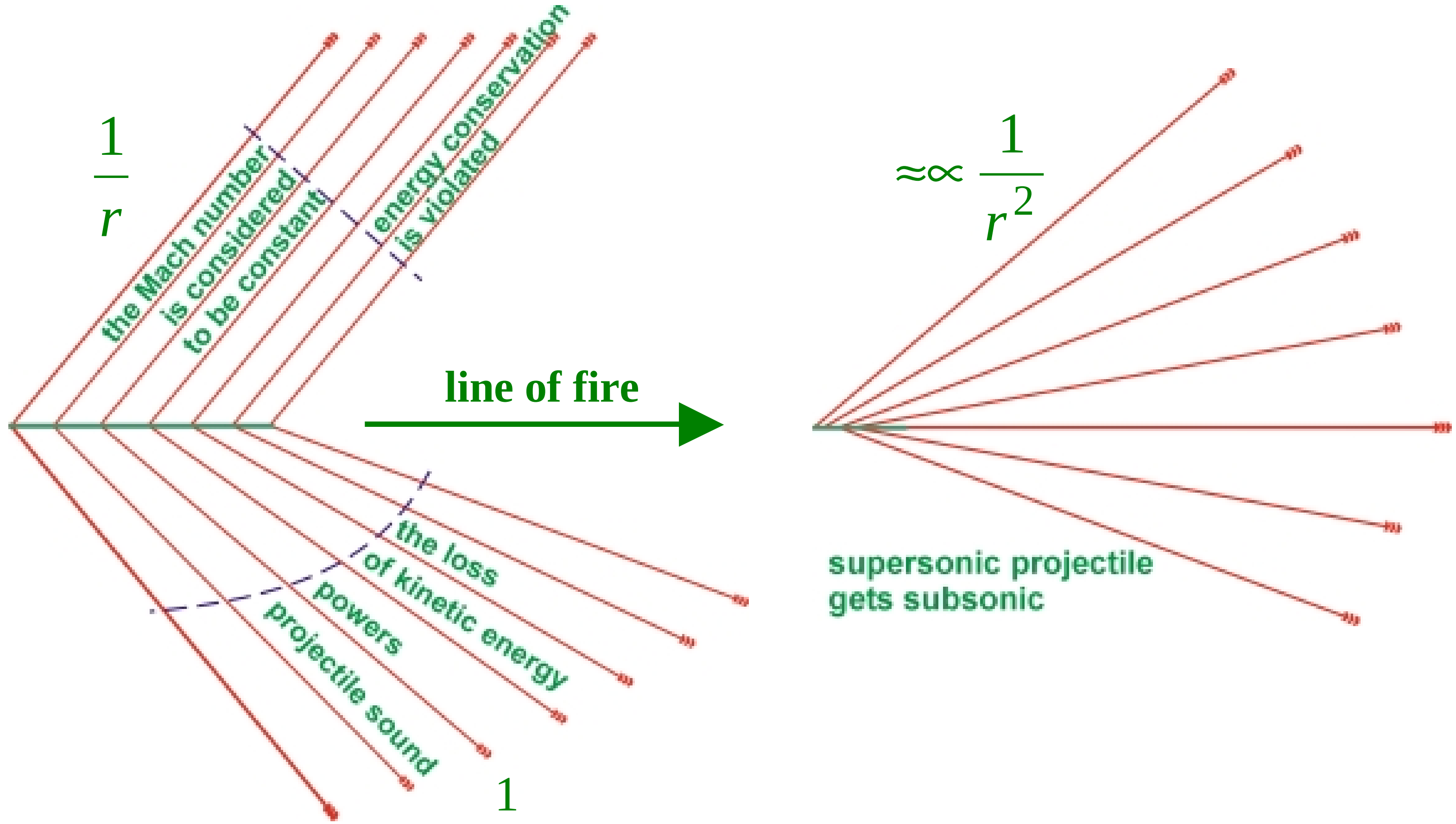
$$F = 1.9513 - 0.10458\, h'_s + 4.05707\, e^{\frac{-(h'_s - 3.9047)^2}{3.428}}$$

$$G_{HOB} = 10 \lg(F)\ dB$$



Source Dependence of Divergence I

Propagation of Projectile sound



$$\frac{1}{2\pi l^2\left[\sin^2\theta_S\left(\frac{\cos\theta_S}{2}+\frac{r_S}{l}\right)+\frac{r_S^2}{l^2}\sin\left(\theta_S-\frac{\varepsilon_S}{2}\right)\sin\varepsilon_S\right]}$$

Source Dependence of Divergence II

- ⇨ Muzzle blast will obey $1/r^2$.
- ⇨ Projectile sound will not obey a constant geometric spreading correction.
- ⇨ By the way, projectile sound is important for clay pigeon ranges.

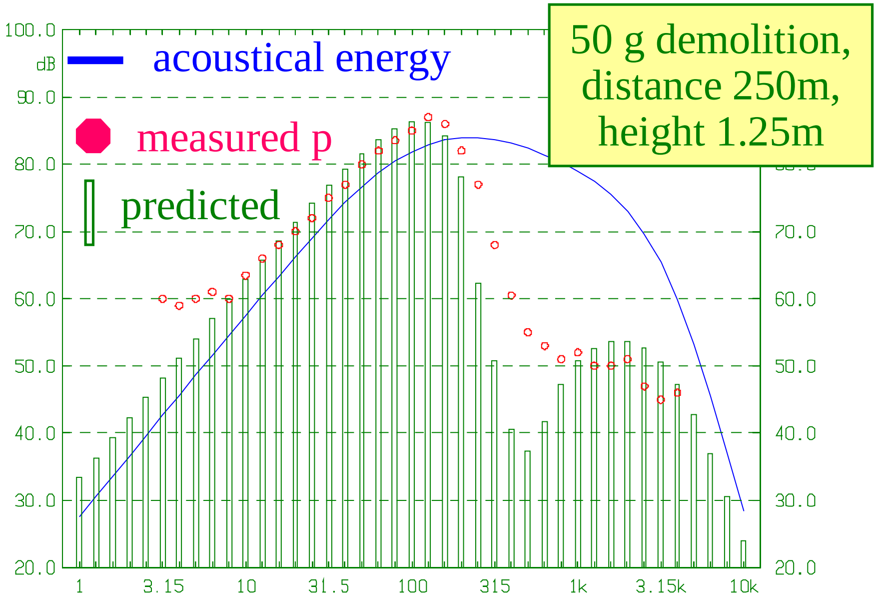
A_{div} needs to be re-defined in dependence on the source

Sound Field Absorption instead of Wave Absorption

Close to the ground there is not a blast wave propagating, but a sound field with two coherent components:

the direct and the reflected wave.

Due to the phase shift produced by typical ground impedances there is pressure release (particle velocity doubling) in the high frequency range.



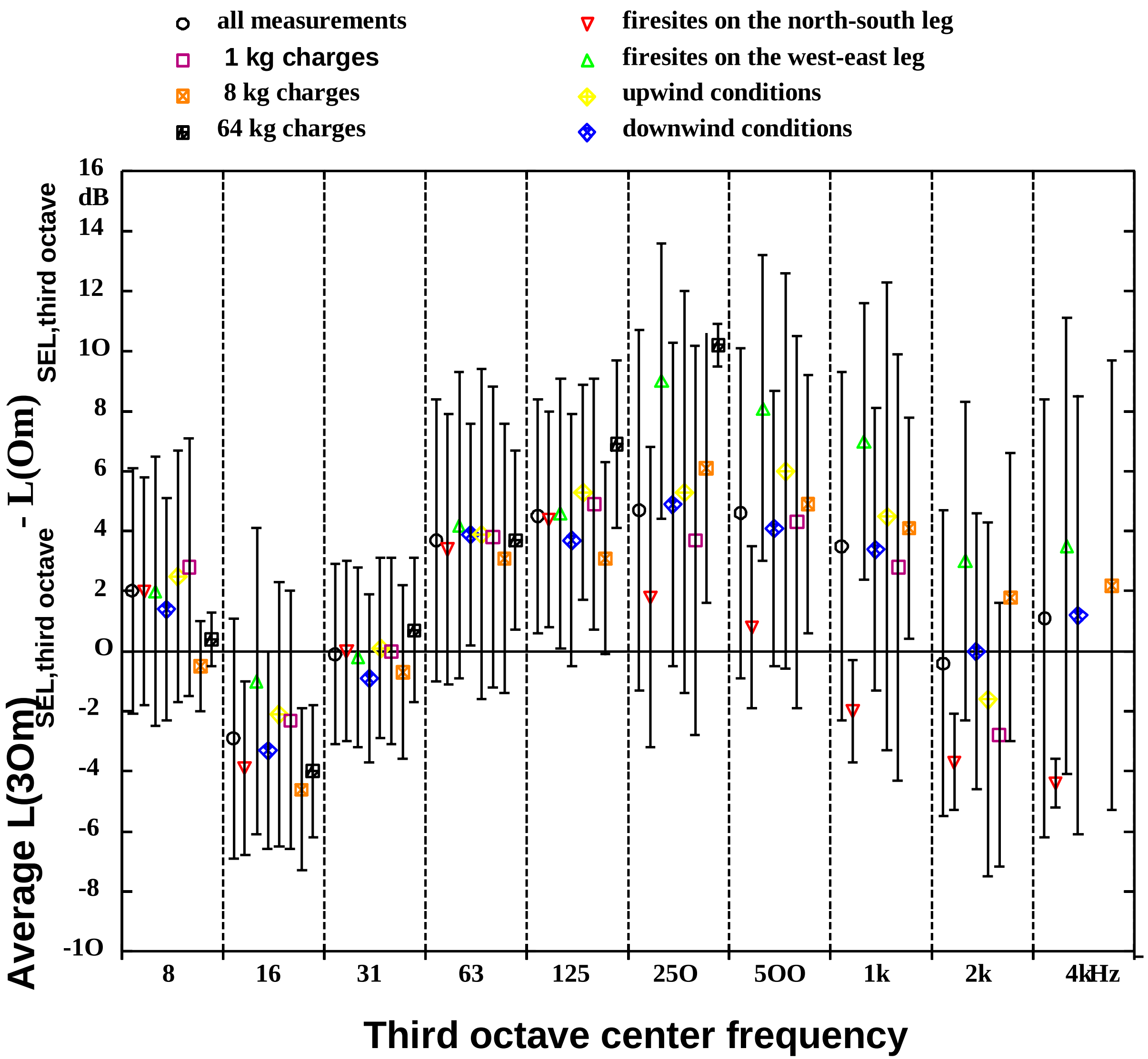
- ⇨ No pressure means no absorption (no inner friction)
- ⇨ High particle velocity means stronger influence of vegetation (high outer friction)
- ⇨ Due to this effect, high frequencies could or could not survive a long propagation distance.

A_{atm} and A_{veg} may be not applicable ?

Influence of Receiver Height I

Norwegian Trials: Spectral differences between 30 m and ground level

The acoustical energy present at both heights is the same!

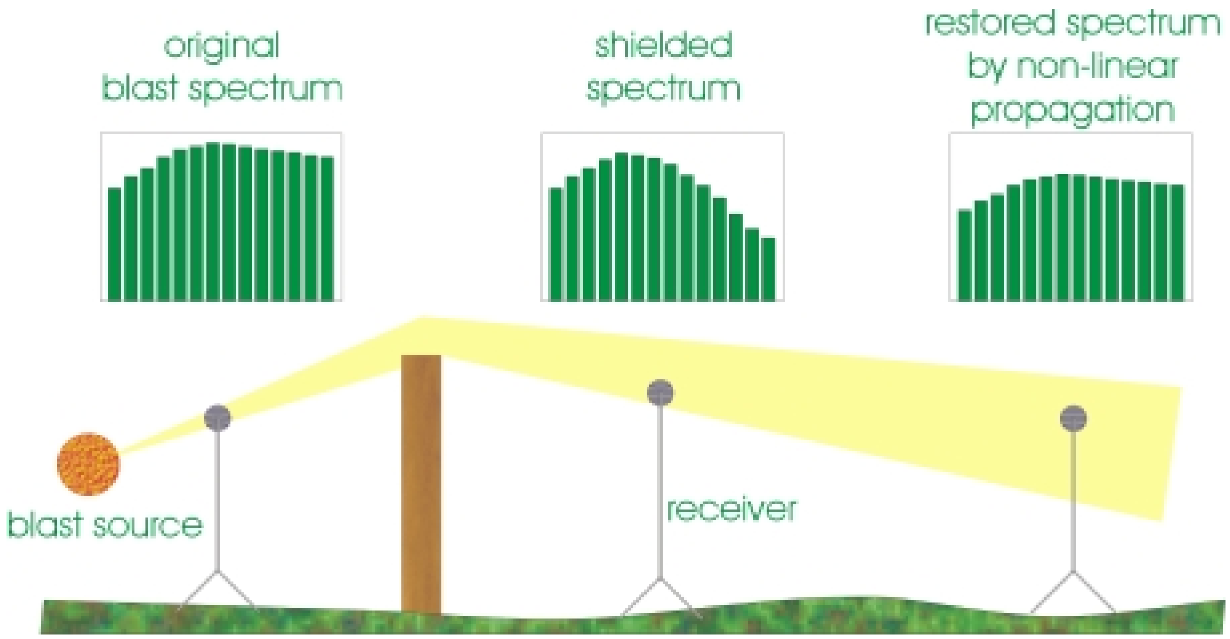


Influence of Receiver Height II

- ⇨ This influence of receiver height depends on the local (receiver site) ground and on the angle of incidence.
- ⇨ It does not depend on wind conditions.
- ⇨ It does not depend on other grounds beneath the propagation path.
- ⇨ Does A_{gr} account for this effect or not?

A_{gr} may be not applicable and there may be a need for an additional correction for weighted pressure levels?

Non-Linear Effects

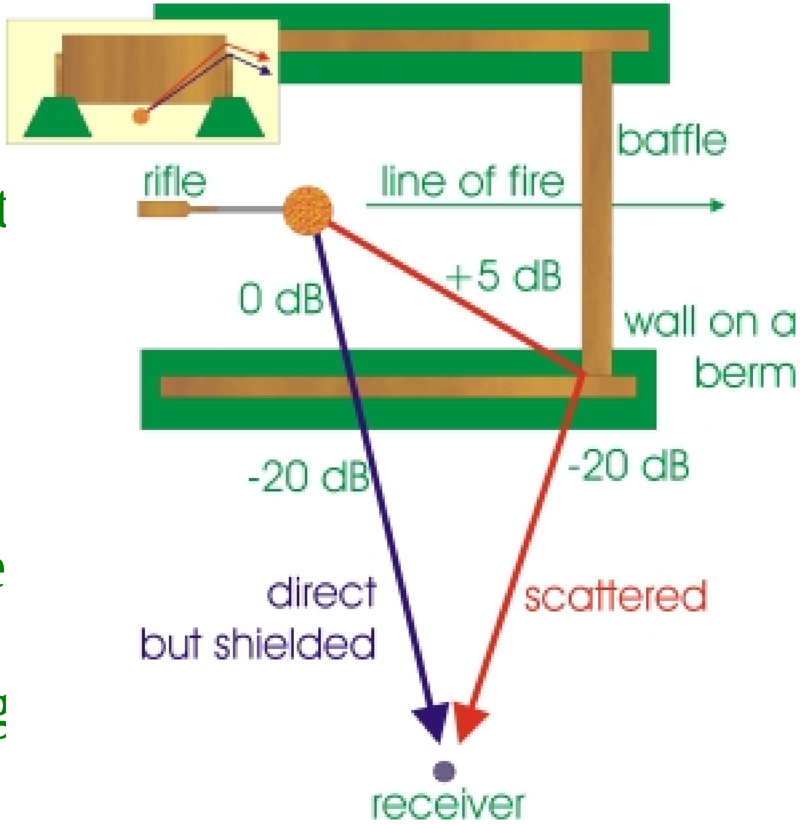


- ⇨ Close to the source, where non-linear effects changes the spectrum along the propagation path, the insertion loss of a barrier is not that what ISO 9613-2 is predicting.
- ⇨ Also absorption in air is different in the non-linear regime.

A_{bar} and A_{atm} needs to be re-considered

Scattering

- Scattering at obstacles is not considered in ISO 9613-2.
- This is because scattered sound normally has levels that are rather low compared to direct or reflected or shielded sound.
- However with shooting noise, scattered sound can determine the receiver level at selected receiver sites due to the strong directivity of the source.



A_{sca} as a new correction may be needed.

Consequences

Due to

- ⇨ coherence,
- ⇨ strong directivity,
- ⇨ non-linear propagation close to the source,
- ⇨ and high energy densities,

shooting sounds are somewhat special
so far propagation is concerned.

However, it may be possible to re-define and
add some more corrections to define a part 3 of ISO 17201
that uses the methods of ISO 9613-2 as far as reasonable.