Sound Suppressor Specification and Measurement

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Topics

- **Characteristics of Sound**
- **Changes required in the acoustic measurement / characterization of suppressors.**
- **The best way to specify the acoustic performance of a suppressed weapon**

What is Sound

- **Variation in Air Pressure.**
- **Air Pressure is measured in Pascals (Pa)**
- **The Larger the Variation, the Louder the Sound.**

Sound Pressure Level

- **Measured in deciBels. (dB)**
- **dB is a logarithmic scale.**
- **1 dB is the threshold of hearing**
- **3 dB represents a doubling in SPL**

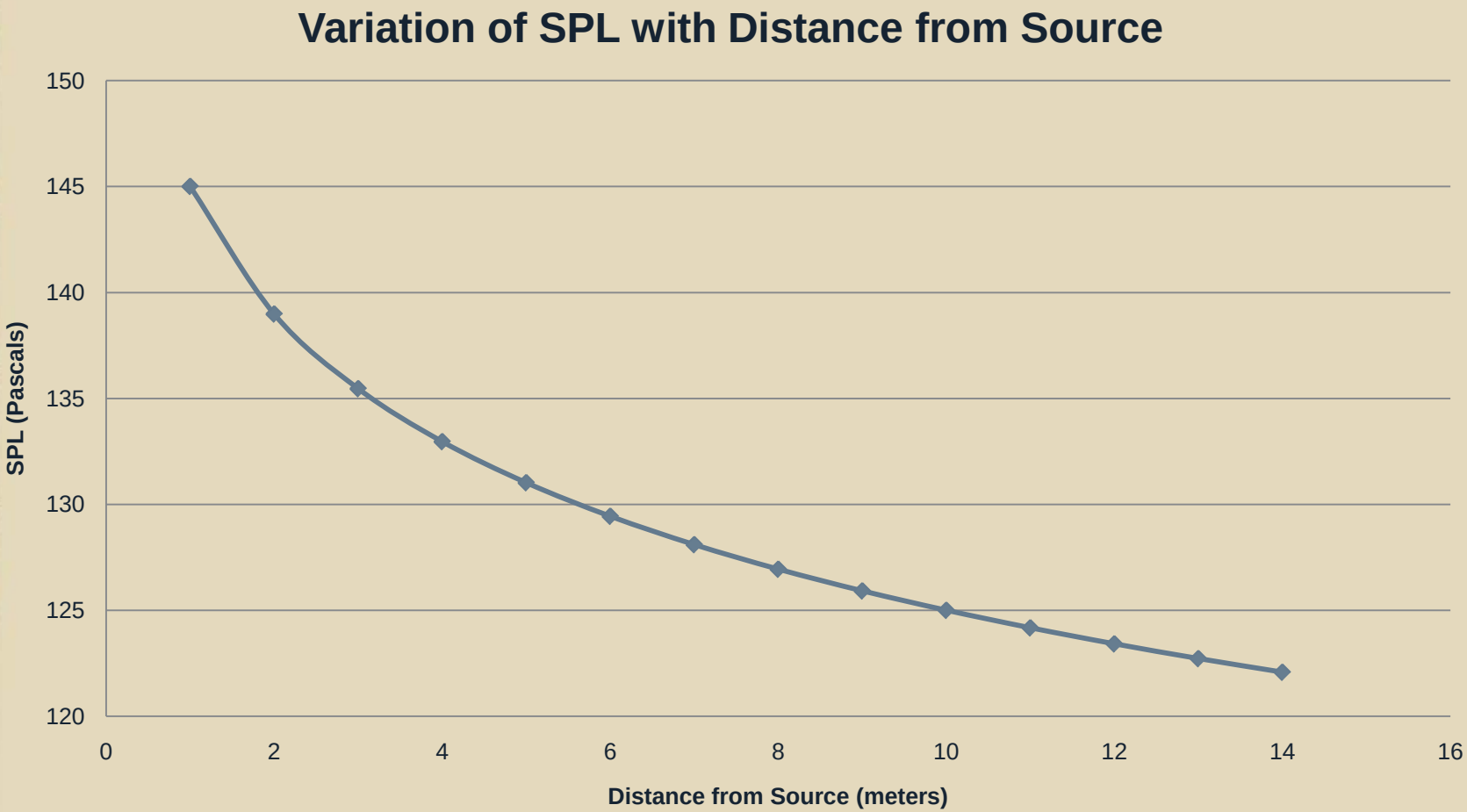
Addition of Sound Pressure Levels

- **dBs can’t be simply added.**
- **For instance**
  - **Sound A = 90 dB**
  - **Sound B = 90 dB**
  - **Sound A + Sound B = 93 dB**

Inverse Square Law

- **Describes the decrease in intensity of a volumetric property as the radius increases.**
- **At twice the distance, 1/4 the power.**

Inverse Square Law II



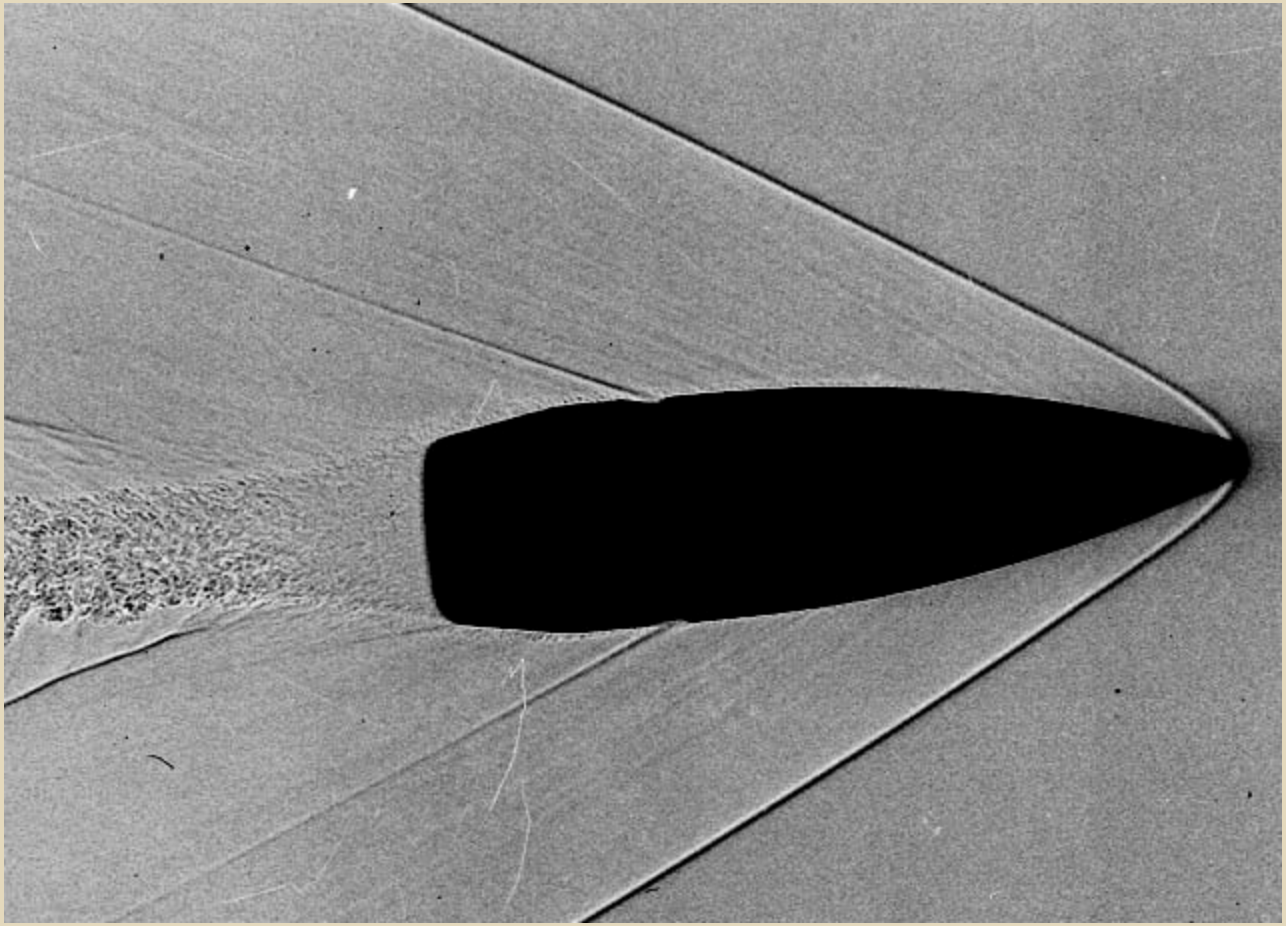
Weighting

- **Weighting is a Filter that attenuates higher frequencies**
  - **Approximation of the Equal Loudness Curve**
- **Current TOP calls for “A-weighting”**
- **Good for measuring Industrial Noise**
  - **For Impulse Noise, C or No Weighting is probably more appropriate.**

Components of Small Arms Sound Signature

- **Crack – Thump**
  - **Crack = Shockwave created by the bullet**
  - **Thump = Muzzle Blast**
    - **Product of Hot Gasses escaping from the muzzle**

Sonic Shockwave (Crack)



Muzzle Blast (Thump)

Speed of Sound(s)

- **The Thump travels at the Speed of Sound**
  - **Generally about 1100 feet/second**
- **The Crack travels with the bullet**
  - **Typical rifle bullet velocities are 2500 to 3300 fps**

Audiolocation

- **Audiolocation is the capability of a person to locate the source of a sound**
- **Location from left-to-right is accomplished by pressure differences and arrival times of the sound**

Audiolocation II

- **The crack arrives at the observer first, followed by the thump.**
- **The crack points at the path of the bullet**
- **The thump locates the shooter**
- **Soldiers are trained to ignore the crack, and wait for the thump**

A Day on the Range

- **MK13 Product Improvement**
  - **Two Barrel Lengths**
  - **Two different loads (190 and 220 gr. projectiles)**
  - **Two different suppressors**
- **Early User Assessment**
  - **Operators expressed that one suppressor was much quieter than the other**

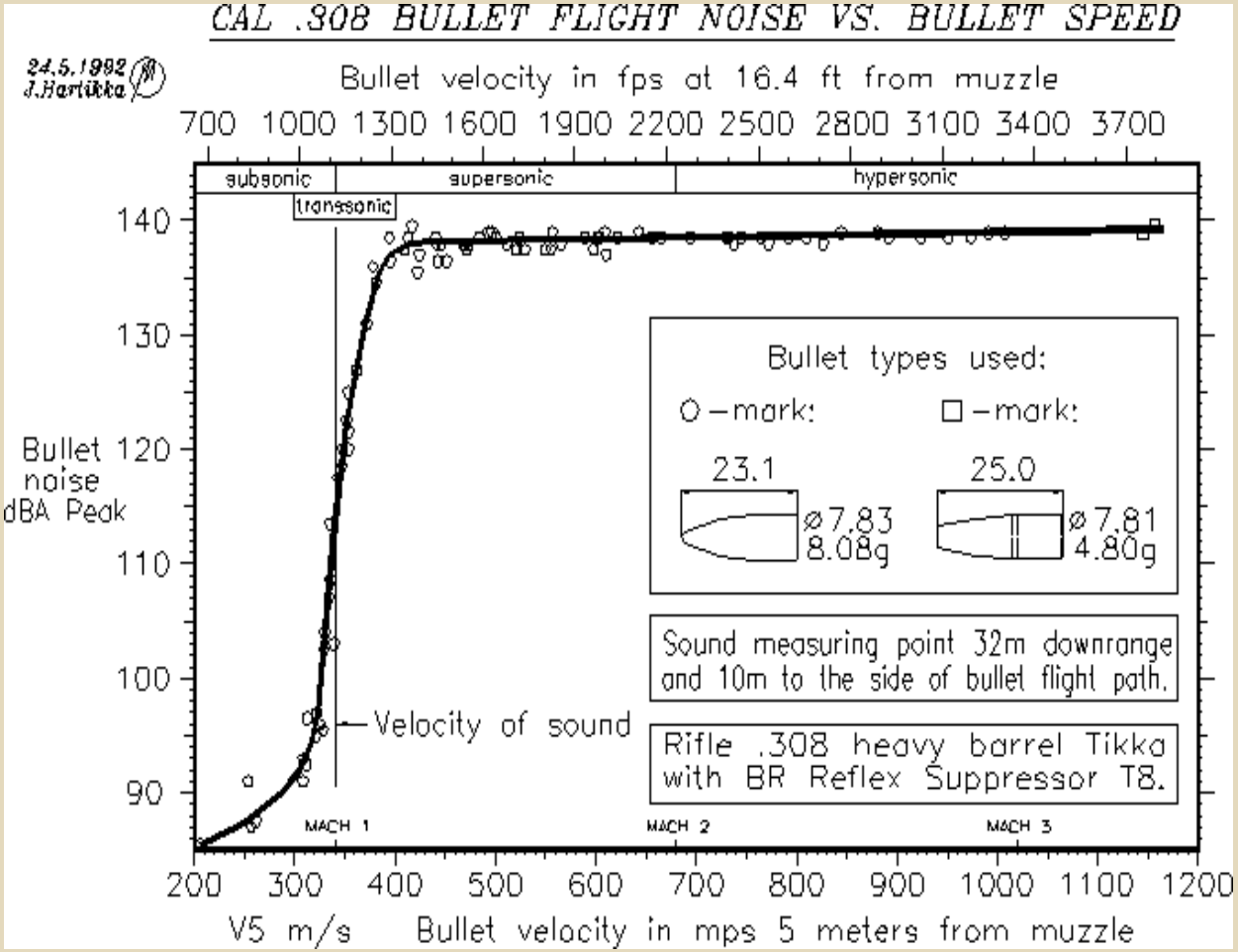
The Surprise

- **Acoustic Signature within 0.3 dB**
- **1 dB is the “Just Noticeable Difference”**
- **0.3 dB should not have made an audible difference to a human**

Hypothesis

- **Suppressors are now efficient enough to decrease the SPL of the Muzzle Blast below the SPL of the Bullet's Crack**

The Magic Chart



Source: http://guns.connect.fi/gow/highpow.html

Other Observations

- **The Major Players in the suppressor industry advertise nearly identical Peak SPL's,**
  - **137 dB**

Pie in the Sky Weirdness

- **Audio Location in the Vertical Plane**
  - **Human head acts like a directional microphone**
  - **Sounds that are in the vertical, front to back plane can't be located by left-to-right pressure differentials**
  - **Head resonates, and causes a frequency shift**
  - **The degree of the Frequency Shift indicates location of the sound**

Pie in the Sky Weirdness II

- **A sound in the 8Khz range indicates that the source is directly behind the observer.**
- **Potential to exploit this?**

A Thought Experiment

- **A sniper engages a target.**
- **A witness catches the sniper's motion out of the corner of his eye, and looks directly at the sniper's position**
- **Immediately afterwards, the report of the rifle arrives at the witness' location.**
- **The frequency of the report tells the witness that the sniper is actually behind him.**
- **In other words, report itself becomes a tool of deception**

Tactical Employment of Sound Suppressors

- **Protects operators hearing to allow communication**
- **Disguises location by short-circuiting audio-location**
- **Acts as a Muzzle Brake**
- **Current Method addresses none of these directly**

Why a New Method?

- **The Current Method:**
  - **Measures “Crack”**
  - **Inappropriate Weighting**
  - **Ignores Spectrum**
  - **Suppressors are no longer add-ons**
  - **Current method offers potential to cheat**

Proposal

- **Use two microphones.**
  - **One at Shooter's Ear**
  - **One 50 meters downrange**
- **Use Inverse Square Law to calculate back to source**
- **Record and report Spectrum**

Suppressor Specification: How it is

- **“X system shall have a …sound suppressor that will reduce audible signal by 24 dB (T), 30 dB (O).**

What's Wrong With That?

- **NSW and USSOCOM now typically procure weapons with suppressors, or the intention to suppress them.**
- **SPL of interest is the "System SPL"**
- **Only Addresses Hearing Protection**
- **Possibility of Cheating**

How to Cheat

- **Use an attachment method that makes the rifle louder**
  - **Muzzle Brake?**
- **Higher Unsuppressed SPL**
- **Greater SPL Reduction...**

Cheating Example

- **Suppressor A: System SPL of 141 dB**
  - **Suppressor A mounts on a standard flash hider**
  - **SPL with flash hider = 164 dB**
  - **22 dB of reduction**
- **Suppressor B: System SPL of 142 dB**
  - **Suppressor B uses a muzzle brake**
  - **SPL with Brake = 166 dB**
  - **24 dB of Reduction**
- **Suppressor B scores better**

Suppressor Specification: How It Should Be

- **The Suppressed Weapon shall have a Muzzle Blast SPL of 130 dB (T) 120dB (O).**
- **In the Future, preferred audio spectra should also be defined.**
  - **Industry needs to demonstrate the capability first.**

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