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ROC No. 198400165W

SOUND LEVEL MEASUREMENT ON BIOSAFETY CABINETS

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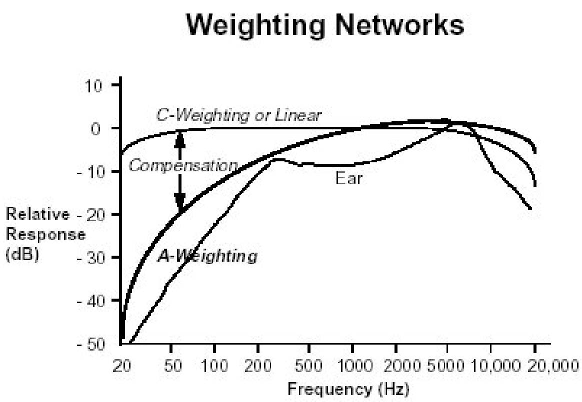
Introduction

Sound is vibration transmitted through a solid, liquid, or gas. Particularly, sound means those vibrations composed of frequencies capable of being detected by ears, and the intensity is commonly measured in *decibel* (dB). Prolonged exposure to loud sound intensity can lead to fatigue and distraction, which can be fatal during a contamination-sensitive work performed in biosafety cabinets, so it's important to measure the sound exposure.

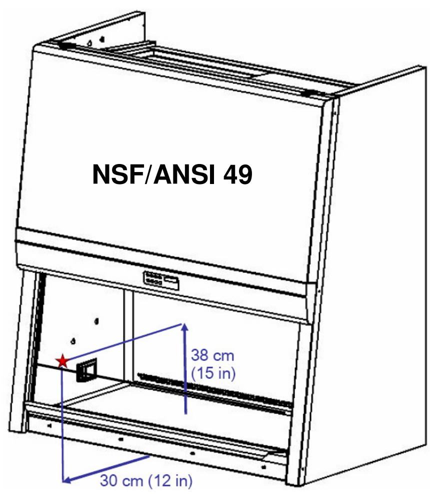
The human hearing system is more sensitive to some frequencies than others. In general, low frequency and high frequency sounds are perceived to be not as loud as mid-frequency sounds, and the effect is more pronounced at low pressure levels. Sound level meters therefore incorporate weighting filters, which reduce the contribution of low and high frequencies to produce a reading that corresponds approximately to what we hear.

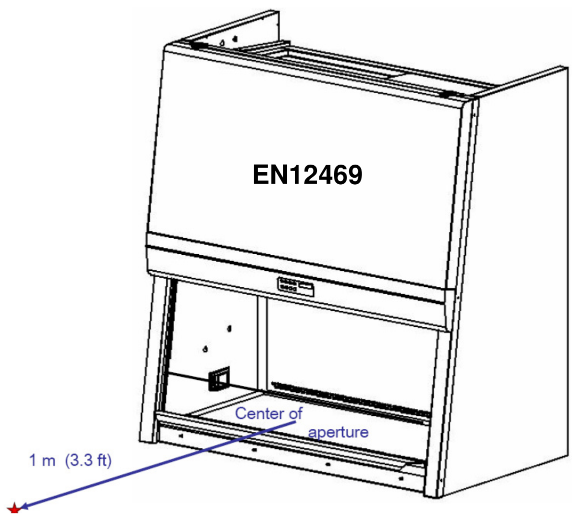
A-weighting, which better resembles human hearing, is more commonly used than C-weighting / linear, which is the actual sound intensity that is received by the sound level meter. The graph below represents the A-weighting, C-weighting, and human ear. The measurement units become *decibel-A* (dBA) and *decibel-C* (dBC).



Measurement Distance

The distance of the measuring microphone from a biosafety cabinet, is determined by the international standard in biosafety cabinetry, namely the NSF/ANSI 49 and EN12469. According to NSF/ANSI 49, the sound measurement shall be performed at 30 cm in front of the front nosing of the cabinet. Meanwhile per EN12469, sound is measured at 1 m in front of the center front aperture. The maximum sound limit imposed by NSF/ANSI 49 is 67 dBA, and the limit imposed by EN 12469 is 65 dBA.





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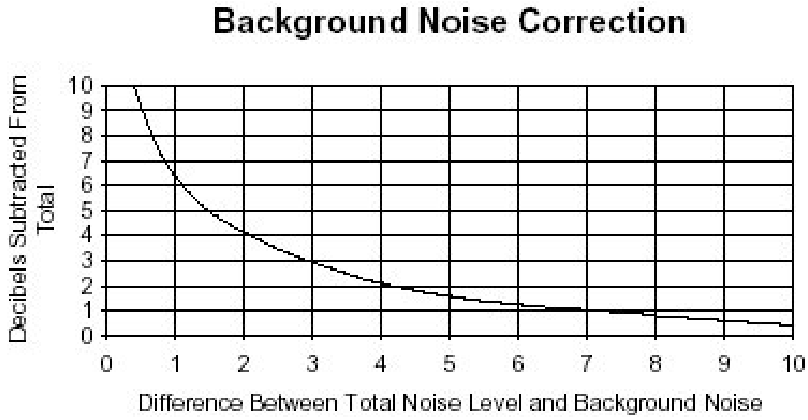
Factors Affecting Measurement Accuracy

There are several factors that can affect sound level testing accuracy. Some of the major factors includes:
1. The accuracy of the noise meter
2. The effect of the background noise
3. The presence of reflective surfaces / objects surrounding the cabinet
4. The presence of reverberation in a closed room

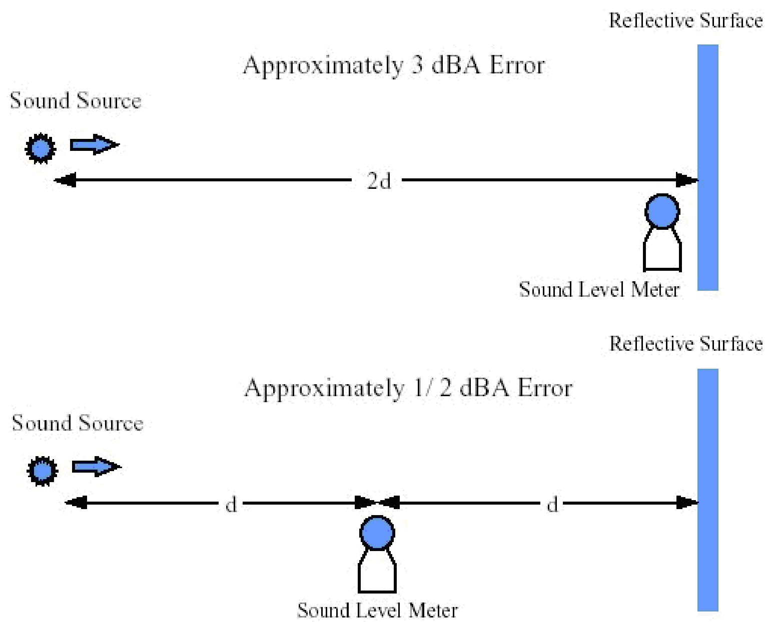
Noise meter accuracy: Per NSF/ANSI 49 requirement, the sound level meter shall have accuracy of ± 0.5 dBA. In worst case scenario, two sound level meters would give a total discrepancy of 1 dBA.

Background noise effect: If the difference between the cabinet noise level and the background noise level is less than 10 dBA which can occur in the factory or lab, the cabinet actual noise reading shall be corrected using the graph below:



Nevertheless, the use of the table above is for approximation purpose only, and it will not give a noise reading as accurate as when there is an ample difference between cabinet and background sound level.

Reflective effect: When a cabinet is tested inside a room that has many other objects or cabinets, such as in the production line or in a lab, the sound reading will be amplified. The wall in front of test cabinet and other cabinets in the room have large reflective surfaces. The effect of on noise measurements that is influenced by reflective objects is shown below:



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Reverberation Effect: Cabinet testing is typically done inside a closed room, such as production line or lab. A closed room produced reverberation effects which significantly increases the sound level measured by the meter. Because of the effects of reverberation within a closed room, accurate noise measurement shall be done in the open field, where there are no walls that can bounce the sound wave back to the meter. An absolutely quiet open field is required to obtain accurate sound reading. This means, there shall be no presence of noise coming from traffic, crowds, airplane, even wind. Because testing cabinets in open field is impractical, the reverberation effect has to be considered on the measurement accuracy.

Improving Measurement Accuracy Using Anechoic Chamber

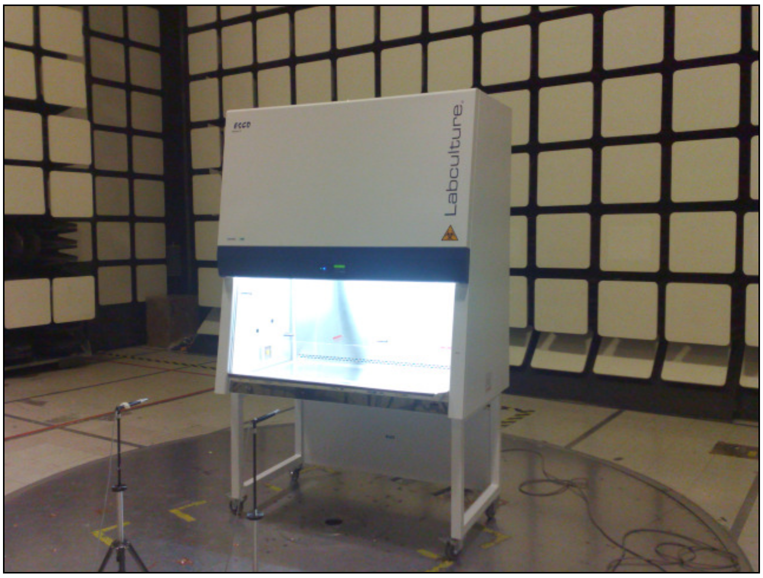
One solution to alleviate the background noise, reflective objects, and reverberation effect in sound level measurement is the use of an anechoic chamber.

ISO 3745:2003 specifies methods for measuring the sound pressure levels on a measurement surface enveloping a noise source in anechoic and semi-anechoic rooms, in order to accurately determine the sound power level or sound energy level produced by the noise source.

An anechoic chamber is a shielded room designed to attenuate waves. Acoustic anechoic chambers are soundproof. It's usually constructed with cement or brick walls to alleviate **background noise effect** by keeping outside sound from entering the chamber. Inside, the chamber is lined with fiberglass wedges or foams to absorb the sound waves and convert them to become heat energy. All sound energy will be traveling away from the source with almost none reflected back, which alleviate the **reflective and reverberation effects.**

Sound Level Measurement of LA2-4L1 Cabinet inside Anechoic Chamber

An Esco Labculture Class II – Low Noise (LA2-4L1) Biosafety Cabinet was subjected to a type-test to measure sound level, inside a semi-anechoic chamber at TÜV-SÜD PSB test facility, as shown below:



The cabinet voltage and inflow velocity was first verified prior to testing, to ensure that it operates on same factory setting. Inflow measurement was performed on-site using Airflow AV30 anemometer, which confirms the inflow of 0.45 m/s, which is the normal operating point of this cabinet.

Two B&K Type 4943 condenser microphones were placed at a distance of 1 m in front of the mid-height of cabinet sash opening, and at 68 cm side-by-side (see picture) These microphones are connected to a B&K Type 2144 real-time frequency analyzer, which the accuracy was checked on site using a Norsonic Type 1251 sound level calibrator. The use of a high-grade analyzer and twin microphone system ensures accurate reading.

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A complete sound analysis from 50 to 10,000 Hz were performed, then the A-weighted sound pressure level of the two microphones were calculated with the result as follows:

Sound Pressure Level	Microphone #1	Microphone #2
Individual reading (dBA)	50.2	50.4
Average (dBA)	**50.3**	

The cabinet was found to yield an exceptionally low noise at **50.3 dBA**, with both microphones provide reading close to each other, so we can be more confident on the accuracy of the measurement.

Conclusion

The Esco LA2-4L1 biosafety cabinet was tested to yield an extremely low noise of 50.3 dBA, when measured with high-grade sound level meter, inside a semi-anechoic chamber that alleviates the background noise, reflective surface, and reverberation effect.

This translates to the safety and comfort for the user, when performing the high-risk, contamination-sensitive work inside this biosafety cabinet.

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