Hear the world in different colours.

Cirrus Research plc
dedicated to noise measurement

噪声及噪声测量简介

声音和噪声

声音由物体振动引起，以波的形式在一定的介质（如固体、液体、气体）中进行传播(想象湖中投入石子产生的波纹)。

人耳和大脑感受到这些振动，形成声音。

凡是干扰人们休息、学习和工作的声音，即不需要的声音，统称为噪声。当噪声对人及周围环境造成不良影响时，就形成噪声污染。

噪声污染与水污染、大气污染、固体废弃物污染被看成是世界范围内四个主要环境问题。

声音和噪声

用一个对数标度来表达声音或噪音的响亮度，以10作为基数，单位为分贝。

SPL=20LOG(10)[p(e)/p(ref)]

人耳能听到的最小声音为20个微帕斯卡μPa， 0dB。即参考声压。

★ 10~20分贝几乎感觉不到。

★ 20~40分贝相当于轻声说话。

★ 40~60分贝相当于室内谈话。

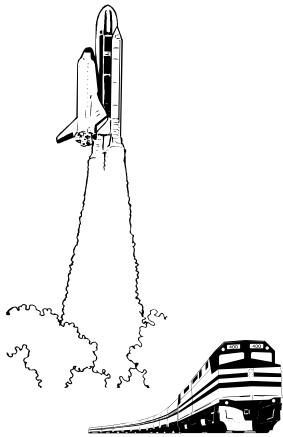
★ 60~70分贝有损神经。

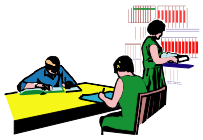
★ 70~90分贝很吵。长期在这种环境下学习和生活，会使人的神经细胞逐渐受到破坏。

★ 90~100分贝会使听力受损。

★ 100~120分贝使人难以忍受，几分钟就可暂时致聋。

★ 噪声级超过140dB时，对轻型建筑开始有破坏作用。





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分贝– The 3dB rule

The disadvantage of the decibel is that because it is a logarithmic ratio, levels in decibels can not simply be added. If we have two identical sound levels to add this is the equivalent to doubling the sound energy.

80dB(A) + 80dB(A) = **83dB(A)**

76dB(A) + 76dB(A) = **79dB(A)**

If we have four identical sound sources ?

Other Examples:

82dB(A) + 84dB(A) = **86dB(A)**

80dB(A) + 87dB(A) = **88dB(A)**

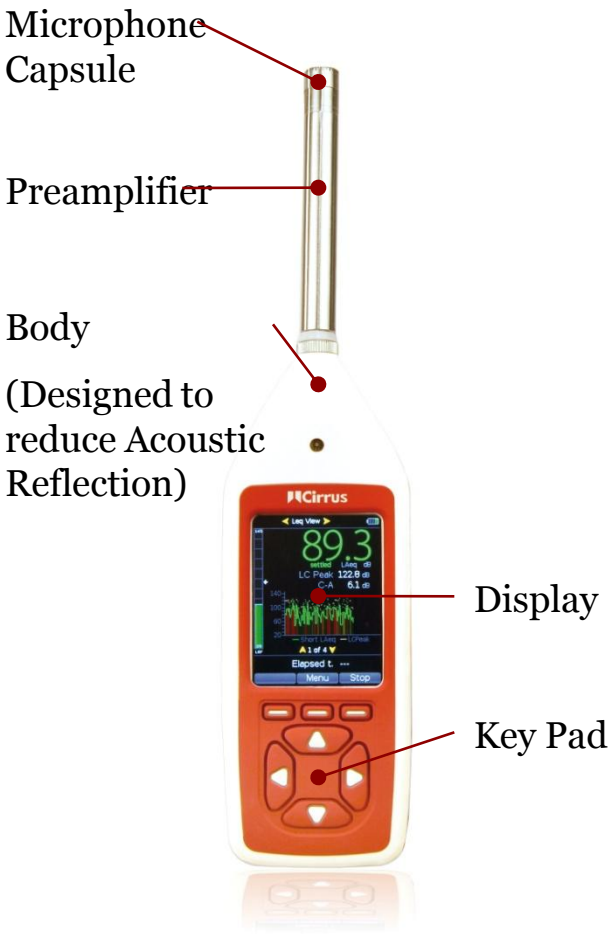
什么是声级计?

把声信号转换成电信号时，可以模拟人耳对声波反应速度的时间特性；模拟人耳听觉在不同频率有不同的灵敏性。

声级计根据国际标准而设计：

- IEC 61672:2003 (GB/T3785-2010) (JJG188)
- IEC 61252:2002 （ GB/T 15952-2010 ）
- IEC61260（ GB/T3241 ）对倍频程滤波器和1/3倍频程滤波器的要求

IEC 欧洲标准
ANSI 美国标准



频率计权

‘A’ Weighting

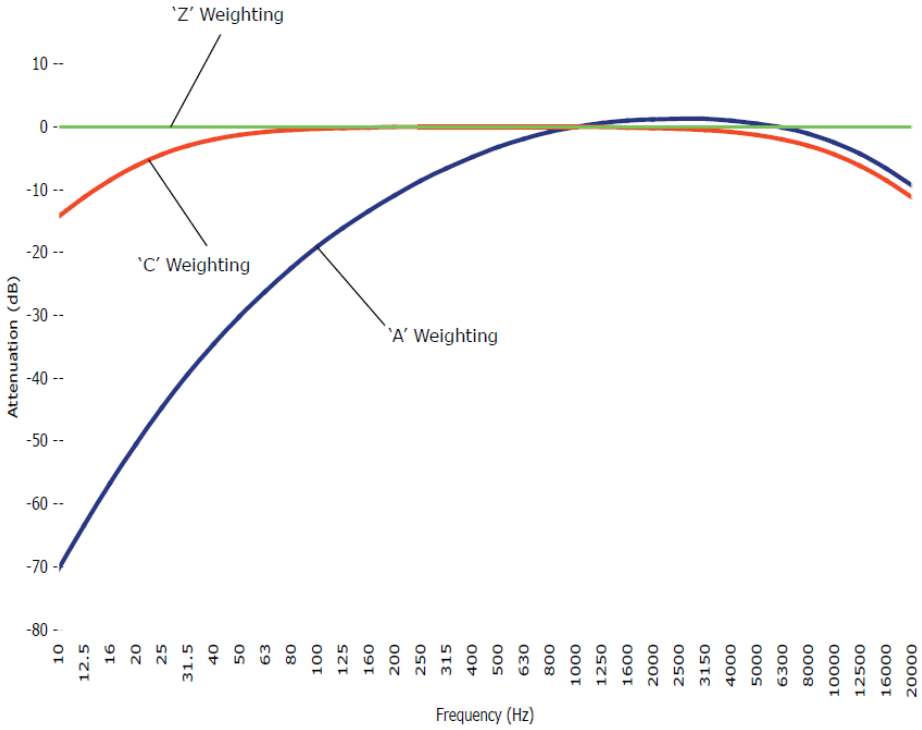
A计权是模拟人耳对声音的响应，使电信号的中、低频段有较大的衰减。A计权滤波器覆盖频率范围为20Hz到20KHz。使用 A计权的测量通常标注dB(A)，例如LAeq，LAFmax，LAE等A表示使用了A计权。

‘C’ Weighting

C计权声级是模拟高强度噪声的频率特性。使用 C计权的测量通常标注dB(C)。通常测量机器噪声。

‘Z’ Weighting

Z计权是对频率范围8Hz到20KHz的水平响应，±1.5dB，不包括传声器响应。使用Z计权的测量通常标注dB(Z)。

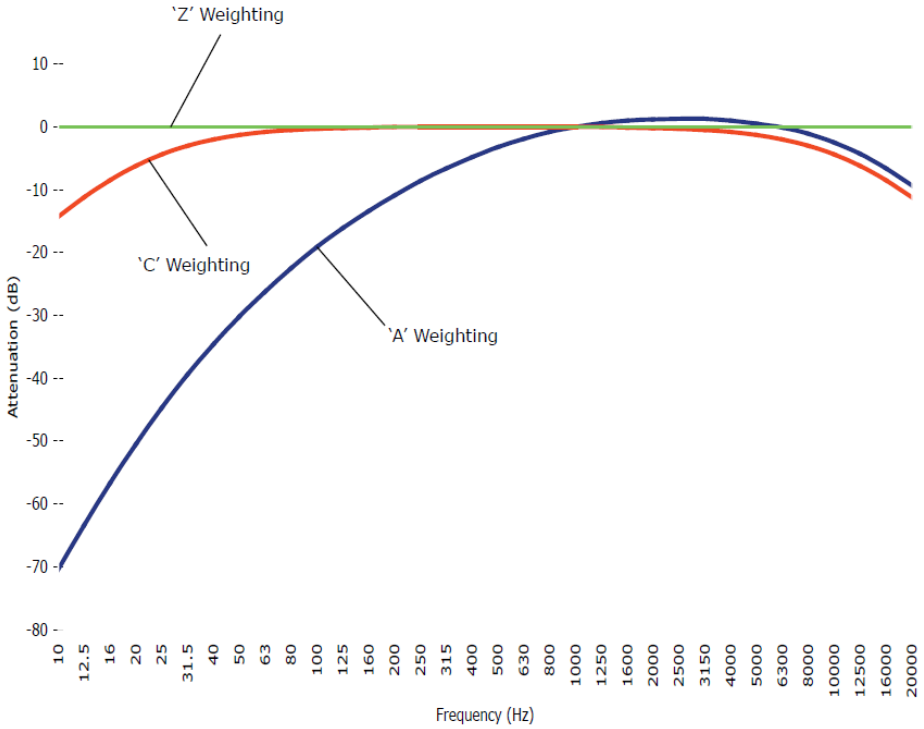


频率计权

‘C’ 计权和 ‘A’ 计权相比，在低频部分衰减较小。

‘C’ 计权在31,5Hz 和 8kHz之间的频率响应是平滑的

通过分别测量‘C’ 计权和 ‘A’ 计权，可以展示低频部分内容。



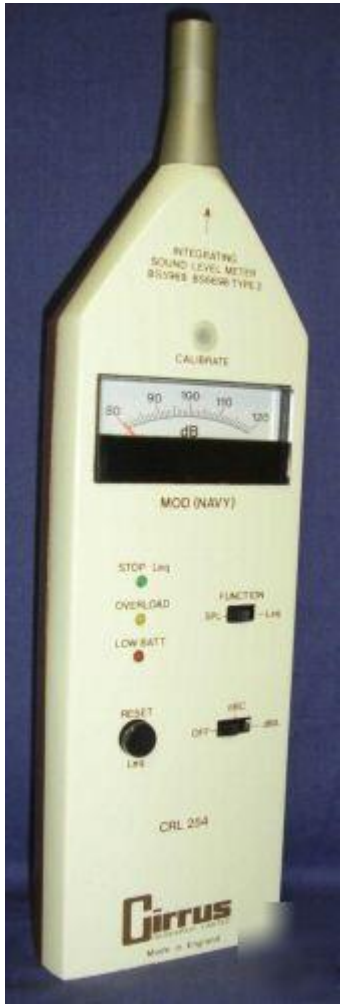
时间计权

Fast　　Slow　　Impulse

“慢”。表头时间常数为 1000 ms ，一般用于测量稳态噪声，测得的数值为有效值。

”快”。表头时间常数为 125ms ，一般用于测量波动较大的不稳态噪声和交通运输噪声等。快档接近人耳对声音的反应。

“脉冲或脉冲保持”。表针上升时间为 35ms ，用于测量持续时间较长的脉冲噪声，如冲床、按锤等，测得的数值为最大有效值。



噪声参数

SPL声压级-声级

e.g. LAS 90dB(A)

最基本噪声参数，瞬时值，根据噪声变化时刻变化。

最大最小声级

e.g. LAS_{max} 95dB(A), LAS_{min} 95dB(A)

在测量过程中，测量设备测量到的的最大最小声压级 (hold function保持功能)。

噪声参数

统计Ln值

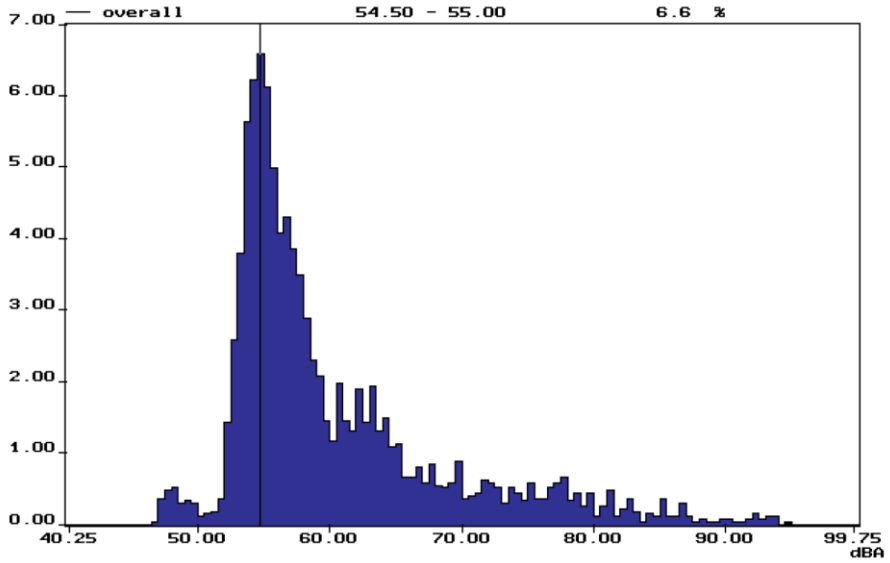
e.g. LAS_{90} dB(A)

声级计计算的统计值。

在超过特定百分比测量时间时，声级的分贝值。

They indicate the dB value exceeded for a predefined percentage of the measurement time.

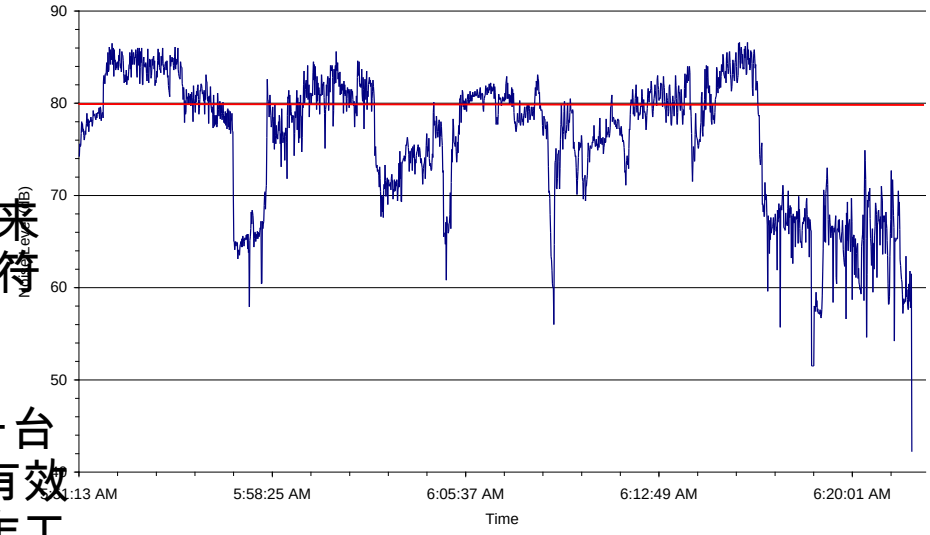
L_{90} 值可以作为衡量背景噪音的参数。即在测量过程中，90% 以上的测量时间的声级是什么。L_{10} 值可以作为衡量交通噪声的参数。



噪声参数- RMS

等效连续噪声(Leq)

e.g. L_{Aeq} 85dB(A) (1hr)



用噪声能量按时间平均（不准确）方法来评价噪声对人影响，即等效连续声级，符号“Leq”。

例如，有两台声级为85dB的机器，第一台连续工作8小时，第二台间歇工作，其有效工作时间之和为4小时。显然作用于操作工人的平均能量是前者比后者大一倍，即大3dB。

等效连续声级反映在声级不稳定的情况下，人实际所接受的噪声能量的大小，它是一个用来表达随时间变化的噪声的等效量。

Noise Parameters - RMS Functions

Equivalent Continuous Sound Level (Leq)

If the noise is varying quickly, the average energy over a period of time is a useful measurement parameter and it is for this reason Leq is often called the Equivalent continuous level. Leq is now used by most countries as the metric of choice for measuring the exposure of workers to noise, as it can be shown that as there is no time constant, it correlates reasonably well to the effect of hearing damage risk

Noise Parameters – RMS Functions

Average Noise Level – Lavg

e.g. LA_{avg} 90dB(A) (Q=5) (3hrs)

Lavg is the same as an Leq – However it is used only when the 3dB rule is NOT applied. Specifically with regard to USA noise at work legislation (OSHA's standard requires the use of 5dB rule). It is required that the measurement defines the quotient value (exchange rate) after the use of the Lavg term (e.g. Q=5).

Often Thresholds are also applied to Lavg Measurements.

Lex8h (Lepd) 和 TWA

等效连续噪声标准化到8小时

8 小时为一般标准每天工作时间

4 Hour LAeq=90dB(A), Lepd=87dB(A)

i.e. the energy measured during the run duration is expressed as a steady noise level over the a fixed 8 hour period.

TWA is generally the same but using the Lavg instead of Leq.

$L_{ep'v}$, Proj TWA, Proj Dose

The Projected Exposure/Dose

Used when a measurement is not made over the entirety of the shift. The instrument calculates the projected exposure based upon the actually measurement and *Criterion Time** to give a projected result.

* Criterian Time is the length of the workers shift and is manually entered into the instrument prior to the measurement by the instrument operator.

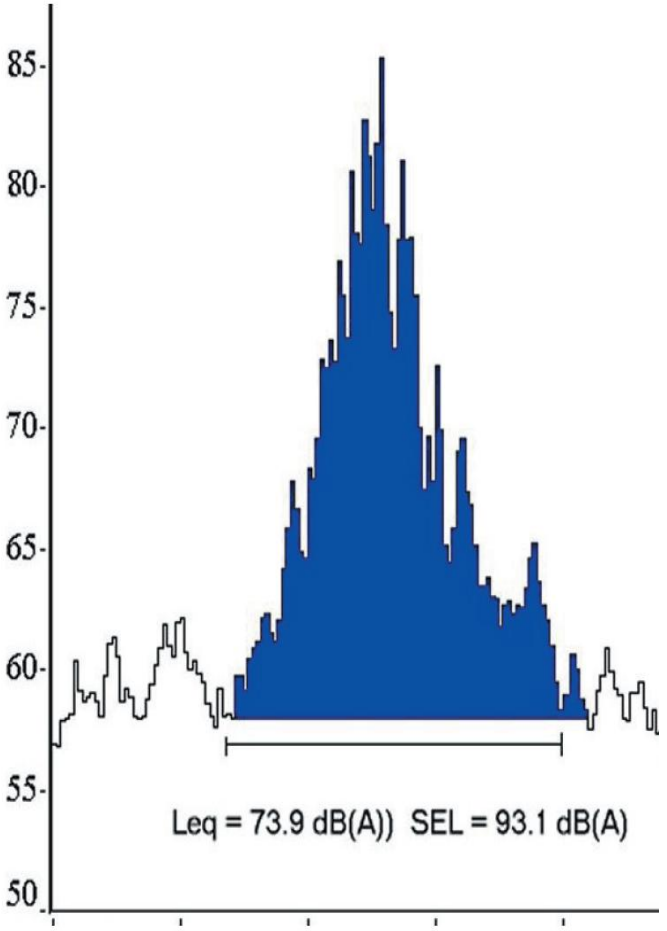
Noise Parameters – RMS Functions

声暴露级– SEL

e.g. L_{AE} 90dB(A)

能量测量Leq时间标准化到1秒。

A SEL is a level of the same energy but “outputted” over 1 sec. It is useful for comparing to Noise Events which have a different time span (like a noisy fast train or a quieter slow train).



峰值测量– Lpeak, Lpk

- 峰值不等同于最大声级，没有时间计权，他不经过RMS计算。
- 峰值不能由最大值计算出来。
- Lpeak 一般用于职业噪声测量，用于测量持续时间很短的脉冲声。
- 一般峰值不用于环境噪声测量，尤其是有风的情况下。一阵风可以导致很高的LCPeak读数。

Thresholds – “Cut off”

The threshold affects the LAVG, TWA, and DOSE measurements.

All sound below the threshold is considered non-existing noise for the averaging and integrating functions therefore not used in the calculation of Lavg, TWA or Dose Functions.

OSHA uses two different thresholds. The original Occupational Noise Exposure Standard (1971) used a 90dB threshold and called for engineering controls to reduce the noise levels if the eight hour TWA was greater than 90dB. The Hearing Conservation Amendment (1983) uses an 80dB threshold and calls for a hearing conservation program to be put in place if the eight hour TWA exceeds 85dB (50% dose). The Hearing Conservation Amendment is the more stringent of the two rulings and is what most US industrial users are concerned with.

Criterion Level

The criterion level is used in the Dose calculation

If the dosimeter is exposed to a decibel level equal to the criterion level for 8 hours the result will be 100% dose.

Example: OSHA mandates the criterion level (maximum allowable accumulated noise exposure) to be 90dB for 8 hours. For an 8 hour sample, an average level (LAVG) of 90dB will result in 100% dose.

频率分析

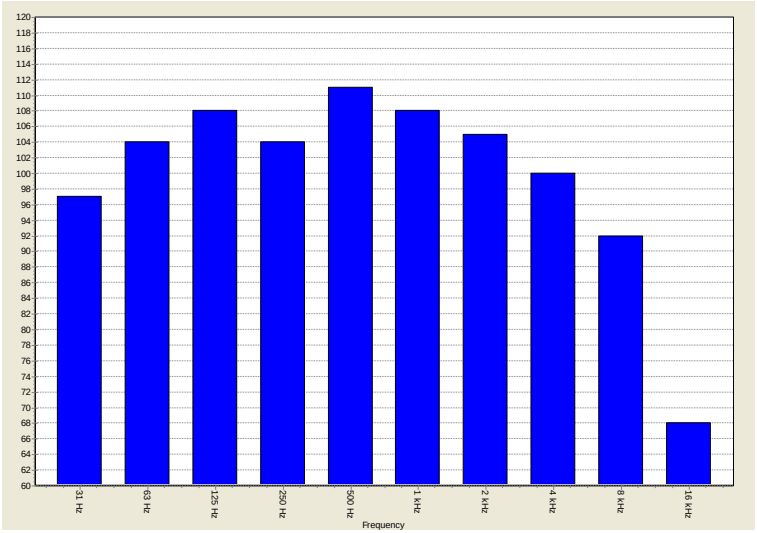
上限截止频率是下限截止频率的两倍的带通滤波器

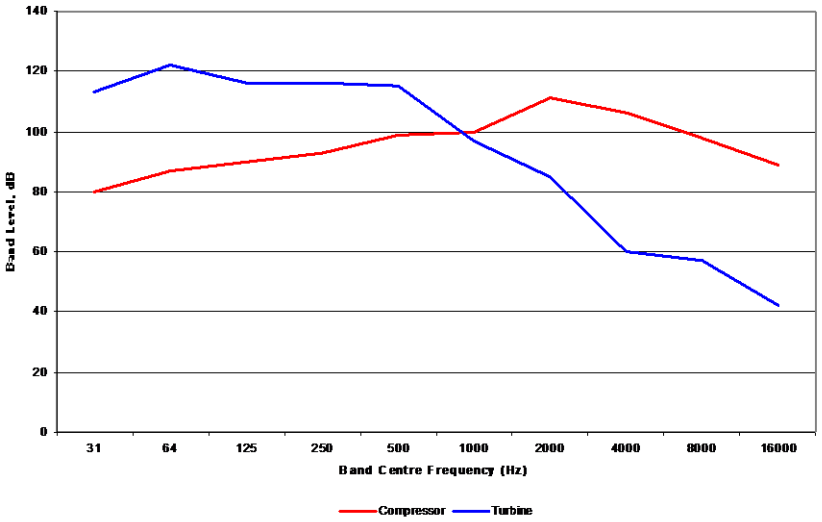
e.g. the octave band with a centre point of 1kHz which has a lower frequency of 707Hz and an upper frequency of 1,414Hz.

Protection. 倍频程分析结果可以用于听力保护，即选择合适的耳塞耳罩等。

Example - the comparison of a turbine and a compressor. In this example both have a broadband Leq of 113dB(A).

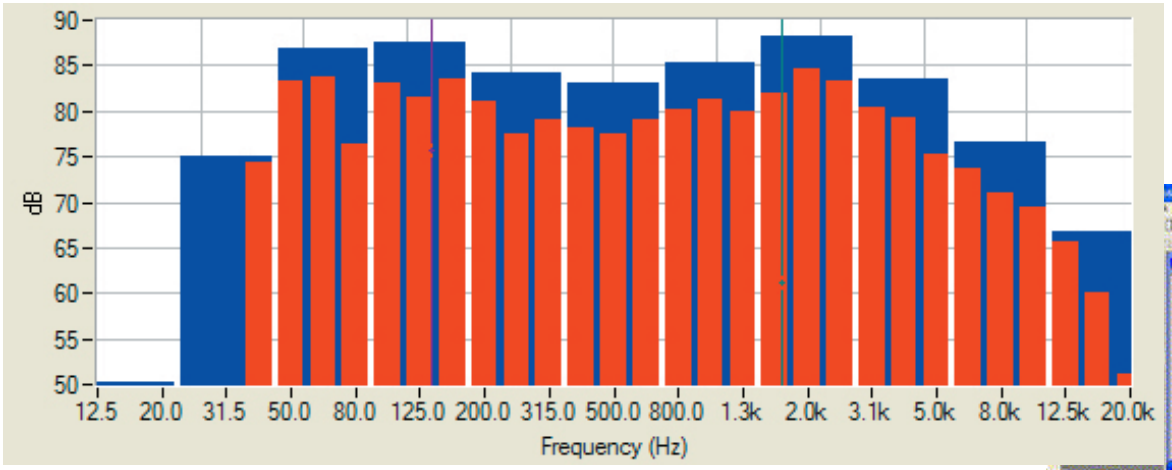
Octave Band Analysis shows the turbine has more low frequency noise than the compressor.

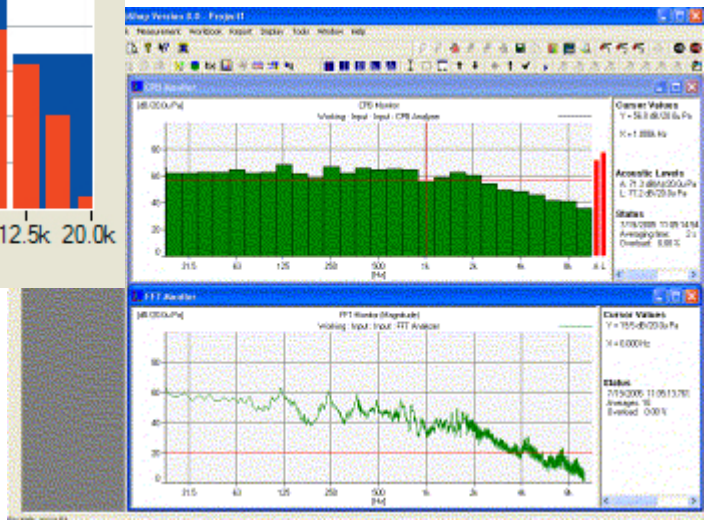




频率分析

在环境噪声分析中，还常用1:3 倍频程分析或者窄带FFT分析。





Questions?

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