Acoustics and using the acoustic calculator

Using the calculator

The source dBA value is the output of the noise source(s) either known or calculated.
The next field is the distance value for the source; specifications for most noise-producing equipment will usually include a value and the distance at which the value is taken, which is usually 3m. If not given, assume 3m.
The third field contains the distance at which the sound value is required. In many practical cases this will be the boundary of the site or the nearest 'noise sensitive place'.

Limitations

The calculator estimates noise attenuation in a free field (inverse square law). This rarely occurs - there will normally be a ground plane at least. If there are no barriers or reflective surfaces in the field this will have little effect on the results. The calculator also does not take into account the extent to which attenuation varies with frequency.

Why use this calculator?

The calculator can be used for on-site noise assessment, e.g. a piece of equipment is running at 70dBA, and is 30m from the nearest noise sensitive place. At this place the noise has reduced to 50dBA. Values for dB are used in the assessment of noise, but the dB scale is logarithmic; you cannot simply add them together, etc. The formulae used by the calculator are

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IL1 = pow(10,(-16+s1/10))
IL2 = IL1*((d1*d1)/(d2*d2))
dbm = 10*log(IL2/pow(10,-16))/log(10)
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Not very easy to do on a pocket calculator!

Basic introduction to acoustics

Average output of some sound sources in watts:

Jet airliner	10,000	(10^4)
Pneumatic riveter	1	
50kW axial fan	0.01	(10^{-1})
Large orchestra	0.001	(10^{-2})
Conversation	0.000001	(10^{-4})

In the carrying medium (e.g. air) the "strength" of sound is usually measured as *intensity*, that is, the density of energy flow rate through unit area, in W/m^2.

When a point source emits sound (or another form of energy) uniformly in all directions in a free field, it is spreading over the surface of a sphere of increasing radius. The same amount of energy is spreading over a larger and larger area, therefore, the intensity will decrease. At a distance of *d* metres from the source it will be:

$I = W / 4\pi d^2$ (as the surface of a sphere is $4\pi d^2$)

Where *I* is in W/m^2.

This is known as the inverse square law.

The average person can hear frequencies from about 20 to 16,000 Hz. (and although not discussed here, frequency has an effect on noise intensity). The lowest intensity perceived as a sound is 10^{-12} W/m^2 and this limit is taken as the standard *threshold of audibility.*

The upper limit is the *threshold of pain* at 1 W/m^2.

The ear has a built-in defence mechanism: its sensitivity decreases for higher intensity sounds. In fact, its response is proportionate to the logarithm of intensity. The logarithm of the ratio of the measured sound intensity to the intensity at the threshold of audibility gives the *sound level scale or decibel* (dB) *scale.*

The number of decibels (N):

$N = 10 \log I / I_0$

Where I is the measured intensity and I_0 is the reference intensity 10^{-12} W/m^2.

The intensity in W/m^2 and sound level (dB) can be compared:

	W/m^2	dB
Jet aircraft at 1 km	0.01	100
Heavy traffic at 10 m from kerb	0.001	90
Office with 10 typewriters	0.000001	60

Not many "offices with 10 typewriters" any more. 10 computer workstations with shared printers would not come close. A workshop with 10 sewing machines might be comparable.

The unit dBA is usually used, as this includes a weighting which enables the different intensity of sounds to be measured by sound equipment, and for environmental assessment, the unit is the average maximum "A" weighted sound pressure level.

Noises at various levels

65 dBA - up to this level, noise or unwanted sound may cause annoyance but the effect is largely psychological. Above this level, physiological effects such as mental and physical fatigue maybe induced.

90 dBA - Years of exposure to this intensity will usually cause permanent hearing loss.

100 dBA - Short periods of exposure cause temporary hearing loss; longer periods are likely to cause irreparable damage.

120 dBA - Causes pain.

150 dBA - Instantaneous loss of hearing.

Noises in a free field

According to the inverse square law, every doubling of the distance will decrease the field intensity by one quarter, or 6 decibels. Higher frequencies attenuate faster than lower (thunder makes a deep noise because the higher frequencies are attenuated first).

Solid barriers will also reduce intensity. For masonry walls, an approximate formula is:

$T1 = 18 \log M + 8$ where T1 is the reduction in dB and M is the mass per unit surface in kg/m^2.

The rule of thumb is that every doubling of the wall mass increases the value of T1 by 5 dB. The above assumes a homogenous barrier (e.g. no holes, weak points) and that the material does not re-transmit noise by vibration or deflection.

Combination of noises

Since the values for dB are logarithmic, two or more sound sources in dB cannot simply be added together, only the values in W/m2. The rules of thumb are that if two equal levels are added, the increase is 3 dB, and if two sounds differing by 10 dB or more are added, there is virtually no increase in level above the highest value. (An increase in sound intensity of 10dB is 100 times; and an increase in sound intensity of 20 dB is 1000 times.)

Likelihood of noise complaints

An increase, intermittent or otherwise, of 10 dBA over background noise is likely to cause complaint.

Background levels between 7.00 am and 6.00 pm for residential areas are likely to be:

Rural/Suburban 30 - 50 dBA

City Areas 45 - 60 dBA

Typical noise levels from construction/extraction equipment:

Source of Noise	**Distance in Metres**	**Range of Noise Levels LAMAXTdB(A)**
Tower Crane	50	62-66
Lorry-mounted crane	25	63-86
Truck	25	67-84
Front-end loader	25	76-84
Bulldozer	25	77-87
Excavator	25	78-82
Rock-breaker • Pneumatic • Hydraulic	25 25	78-104 74-83
Rock drill • Pneumatic • Hydraulic	25 25	82-92 72-82
Jackhammer	25	77-86
Sheet piling • air hammer/drop hammer • vibratory system • enclosed drop hammer	50 50 50	83-98 72-93 67-77

compressor • little or no sound control • 'silenced'	7 7	67-89 65-81
Nail gun	25	68-78

Average maximum values should not exceed 75 dBA measured at 3.5 m from the boundary of the sound sensitive area.

Environmental Values

The source document is *Environmental Protection (Noise) Policy 2008* which sets out the criteria for the assessment of noise. This section provides a summary to assist in using the calculator for preliminary assessment of noise conditions. It is not intended as a substitute for the Policy.

Background noise
The Policy has an "Acoustic Quality Objective" (Schedule 1 Section 8) of achieving an ambient level of 30 - 65 dBA for indoor and outdoor residential premises. 55dBA can serve as a preliminary target value - e.g. if an activity produces more than 55 dBA at the boundary, remedial measures may be required.

The Policy sets out requirements for assessing noise for other types of premises that are not discussed here.

Typical maximum values for nearest noise sensitive place:

Airports	70 dBA	Max (S) time weighted 5min/24hour
Roads:		
State	68dBA	L10(18hour) level
Local	63dBA	L10(18hour) level
Night	60dBA	10pm/6am 1 hour equiv
Single event	80dBA	maximum
Railways:		
Average	65dBA	24hour equiv
Single event	87dBA	maximum

Maximum increase or noise values for a range of activities:

Indoor venues	increase ‹=10dBA	day or evening
Indoor venues	increase ‹=8dBA	other times - by octave band
Outdoor venues	55dBA	Leq (15min)
PA systems	‹=15dBA	affected business premises

PA systems	‹=10dBA	affected dwelling
Racing boats	95dBA	av. max at 30m
Power boats	75dBA	av. max at 30m

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