Audible Range

The output of all audible signals is expressed in decibels or dB(A) which is a measure of sound pressure level. The dB figure is always quoted at a certain distance from the signal, usually 1m although 3m is sometimes used and on very large sirens it may be quoted at a distance of 30m.

When both the sound output of a signal and the distance at which it was measured is known it is possible to calculate the sound level at other distances. This can be done by using the "Inverse Square Law" which states that the sound level will reduce by 6dB from the measured value at a distance double that of the measured distance. The effective distance of a sounder using this simple method is when the calculated dB(A) reaches 5dB(A) above the known ambient background noise (As stated in BS5839 Part 1).

For example the effective distance of a 100dB(A) @1m sounder in an ambient of 65dB(A) is the distance at which the sounder output level reduces to 70 dB(A) i.e. 100dB – 30dB = 70dB. From the table opposite (and using the inverse square rule / rule of thumb) a reduction of 30 dB means the sounder has an effective 70dB distance of 32m.

The sound level figures quoted in this catalogue are based on measurements made in an anechoic chamber which is a room, free of any obstructions, with still air, and with sound absorbing walls to eliminate reflections. The "Inverse Square Law" will only apply under similar conditions.

Selecting a Siren

In practice the conditions are far from those found in an anechoic chamber. There are obstructions such as buildings, trees and hills, there is usually some wind and of course there is some background noise.

The following should be considered when selecting how loud and what type of siren or sounder should be used.

1) Area to be covered
2) Ambient noise level and frequency
3) Location indoors or outdoors
4) Single or multiple tones required

How loud a siren needs to be can be determined by the inverse square law as described above. The frequency of the siren is also important. With high frequencies sound tends to reflect off obstacles whereas, with low frequencies the sound will tend to pass through obstacles. The frequency of the ambient noise is also significant, and the signal should have a frequency that is above or below that of the ambient noise.

In general, signals with high frequencies and multi-tones are ideal for indoor use and for areas with a high ambient noise. Low frequency signals are better suited for outdoor large area applications. For large areas, consideration should be given to the wind conditions in both the selection of the signal and in its location. It should also be noted that for large areas it is often more effective to use several smaller signals rather than one large signal and if a large signal is chosen the effect on personnel in close proximity to the signal needs to be considered.

Types of Signals

Audible signals can be divided into four types-

- Bells
- Horns and buzzers
- Motorised Sirens
- Electronic Sounders.

These are detailed below:

BELLS

Bells consist of a metal dome or gong which is struck repetitively by a metal plunger or hammer. The plunger is driven by either a small motor or more commonly a solenoid. They have the advantage of a distinctive sound, low current consumption and low cost.

HORNS AND BUZZERS

Horns or buzzers generate sound by vibrating a metal diaphragm either electrically with a coil or with compressed air. The sound is then usually attenuated by using a trumpet. They are however limited to low frequencies usually below 500Hz. Current consumption is low and very high sound levels are possible with compressed air horns.

MOTORISED SIRENS

Sirens consist of a motor driven slotted cylinder or rotor, which spins inside a slotted case. Air is drawn through the centre of the rotor and is expelled through the slots in the case generating sound in the process. They are available from very small up to very large sizes with the sound frequency tending to decrease with increased size.

Motorised sirens have the advantage of a distinctive sound which can be varied by switching the motor on and off at short intervals to produce a wailing sound. However they also have high current consumption and are often short time rated.

Electronic Sounders

Electronic sounders consist of an electronic circuit which produces sound via a sound transducer or speaker. They can produce single or multi-tone sounds and will often give the user a choice of sounds and volume control. They have low current consumption and are continuously rated, however low sound frequencies at high outputs are difficult to obtain. Electronic sounders also offer the possibility of producing pre-recorded voice messages to reinforce the warning given by a tone output. They can also readily incorporate a light source to give a very effective visual and audible signal in one device. New generation high power wide area warning systems are a variation on the traditional electronic sounder. Utilising high power amplifiers and separate speaker arrays with customised tones and voice messages are stored in memory. They provide an effective alternative to the traditional motor driven siren.

AUDIBILITY TABLE

The following table gives the sound level that can be expected under ideal conditions at a range of distances from the signal source.

m	dB																					
1	75	80	85	90	95	100	102	104	106	108	110	112	114	116	118	120	125	130	135	140	145	
2	69	74	79	84	89	94	96	98	100	102	104	106	108	110	112	114	119	124	129	134	139	
3	65	70	75	80	85	90	92	94	96	98	100	102	104	106	108	110	115	120	125	130	135	
5	61	66	71	76	81	86	88	90	92	94	96	98	100	102	104	106	111	116	121	126	131	
10	55	60	65	70	75	80	82	84	86	88	90	92	94	96	98	100	105	110	115	120	125	
20	49	54	59	64	69	74	76	78	80	82	84	86	88	90	92	94	99	104	109	114	119	
30	45	50	55	60	65	70	72	74	76	78	80	82	84	86	88	90	95	100	105	110	115	
50	41	46	51	56	61	66	68	70	72	74	76	78	80	82	84	86	91	96	101	106	111	
100		40	45	50	55	60	62	64	66	68	70	72	74	76	78	80	85	90	95	100	105	
200			39	44	49	54	56	58	60	62	64	66	68	70	72	74	79	84	89	94	99	
300				40	45	50	52	54	56	58	60	62	64	66	68	70	75	80	85	90	95	
500					41	46	48	50	52	54	56	58	60	62	64	66	71	76	81	86	91	
1000						40	42	44	46	48	50	52	54	56	58	60	65	70	75	80	85	
2000									40	42	44	46	48	50	52	54	59	64	69	74	79	
3000												42	44	46	48	50	55	60	65	70	75	
5000														42	44	46	51	56	61	66	71	

Note: An increase of 3db is the equivalent to doubling the volume. For example a siren with an output of 110dB is approximately 8 times louder than one with an output of 100dB. The effective distance of a siren is when the calculated dB(A) is at least 5dB(A) above the known ambient background noise. For example the effective distance of a 100dB(A) @ 1m siren in an ambient noise of 65dB(A) is the distance at which the sounder output reaches 70dB(A) (ie 100dB-30dB=70dB). From the table above (or using the inverse square rule) a reduction of 30dB means the sounder has an effective distance of 32m.

A 120dB(A)@1m siren has a 70dB(A) distance of 300m ie. Ten times the effective distance and more importantly 100 times the coverage area of a 100dB(A) siren.

Two identical sirens placed together will produce a combined output of 3dB greater than their individual outputs. Four identical sirens will produce an increase of 6dB. ie 4x 100dB(A) @ 1m sirens will together produce 106dB@1m.

A further adjustment to the above table should be made to take into effect the tone frequency-

Sound Frequency	Adjustment
Up to 500Hz	0dB(A)
500Hz to 1000Hz	-3dB(A)
1000Hz to 2000Hz	-5dB(A)

Other points to consider-

a) In the open a siren will spread the sound in all directions, whereas in an enclosed space some of the sound will be reflected from hard surfaces and increase the sound level.

b) The closer a wall mounted siren is positioned near a ceiling the more sound will be reflected. The same is true of a ceiling mounted siren positioned near a wall.

c) A siren mounted on a wall will be more effective than one mounted on a pillar.

d) Sirens should be positioned to avoid immediate obstacles. Ideally at a height of 2 to 2.5m above the floor.

e) Large outdoor sirens should be mounted 10-12m above ground level or 2-3m above any nearby obstacles such as buildings or trees.