
# SILENCERS



## Basic Principle of Sound

Noise is an unavoidable part of everyday life and technological development has resulted in an increase in noise level from machines, factories, traffic etc. It is therefore important that steps towards a reduction in noise are taken, so that noise is not something we have to accept. In connection with this fight against noise, you must have some basic knowledge about how and where is noise generated, transmitted and attenuated in system in order to be able to select the proper principle and products.

This description does not claim to teach you how to calculate and attenuate noise in a ventilation system - there are books available on this.

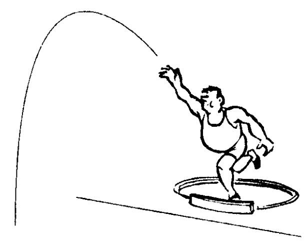
This description only aims at providing information about a few simple rules and hints, which together with common sense can be enough for simple installations.

To take a simple analogy: noise transmission consists of waves in a medium, i.e. air, which we can not see. This is very similar to the way waves spread on water.

Let us examine the analogy, to make the comparison clearer:

### Source

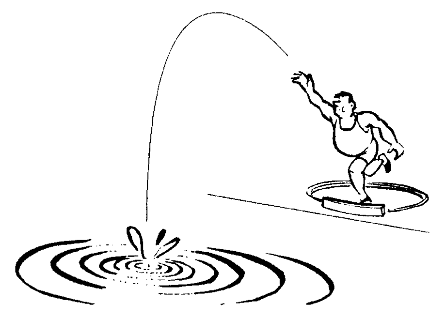
**Waves on Water**
We throw a stone onto completely calm water.



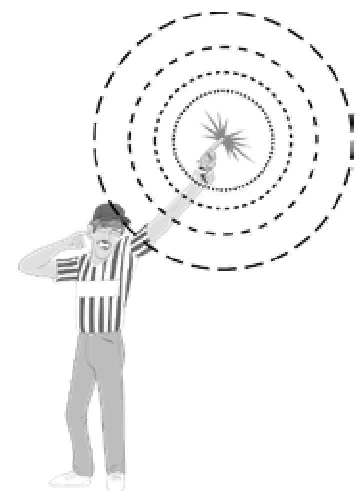
**Waves in Air**
We fire a starter's gun.

### Distribution

**Waves on Water**
Waves on water spread out in increasing concentric circles from the centre, where the stone hit the water.



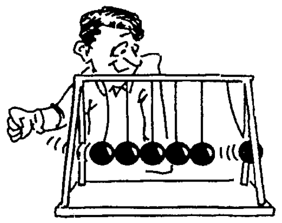
**Waves in Air**
Sound waves spread out in the air, in all directions, in an increasing ball from the centre, i.e. the gun.



## Energy Transport

**Waves on Water**
Kinetic energy is transmitted from molecule to molecule in the water. They bounce against each other. Molecules move back and forwards. Energy spreads from the source.

**Waves in Air**
Kinetic energy is transmitted from molecule to molecule in the air. They bounce against each other, and move back and forwards. Energy spreads from the source.



## Distance

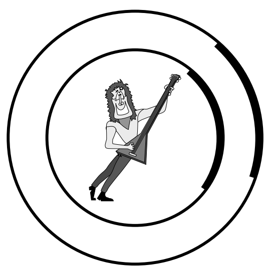
**Waves on Water**
When waves depart from the centre, where the stone hit, the wave height becomes lower and lower, until they are invisible. The water is calm again.

**Waves in Air**
When sound waves depart from the source, the starter's gun, wave movement drops off and the sound becomes weaker and weaker until it can no longer be heard.

## Intensity

**Waves on Water**
The energy which started the wave propagation, or the power needed to keep it going, is distributed across and increasing area as the distance, the radius, increases

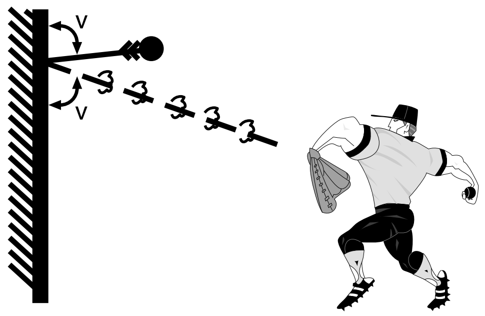
**Waves in Air**
The energy which started the wave propagation, or the power needed to keep it going, is distributed across an increasing volume as the distance, the radius, increases.



## Obstruction in the Way

**Waves on Water**
If waves in water encounter the side of a boat or jetty, they will be reflected at the same angle as they met the obstruction.

**Waves in Air**
If waves in air encounter a wall, they will be reflected at the same angle as they met the obstruction.




In the same way as when you bounce a ball on the wall.

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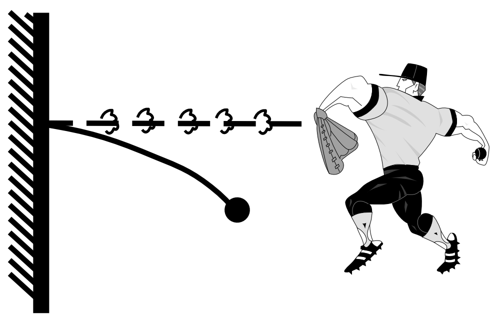


In the same way as when you bounce a ball on the wall.









## Absorption

**Sound can be absorbed**

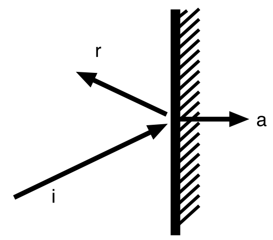
When sound waves meet a soft, porous wall (mineral wool etc.), the vibrating molecules penetrate the surface layer, and are then braked by friction against the material fibres.

The part of the energy which is thus absorbed is converted to heat in the material, and the rest is reflected back into the room. This type of damping, where the sound is braked by the soft surface layer, is referred to as porous absorption.

The sound absorption ability of different materials varies. This property is expressed as the sound absorption factor of the material.

$i = a + r$

$\alpha = \frac{a}{i}$




If nothing is absorbed, everything is reflected, then a = 0 which makes = 0:

$i = a + 0$ $\qquad \alpha = \frac{a}{a} =$

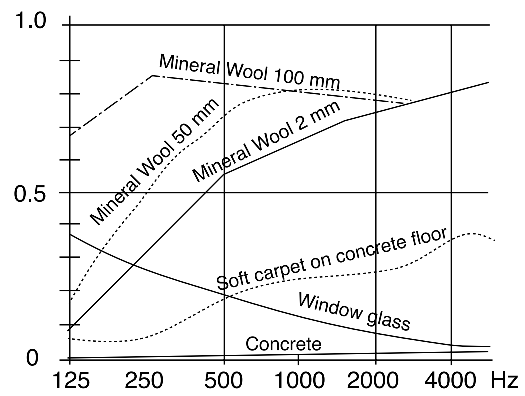
If nothing is absorbed, everything is reflected, then a = 0 which makes = 0:

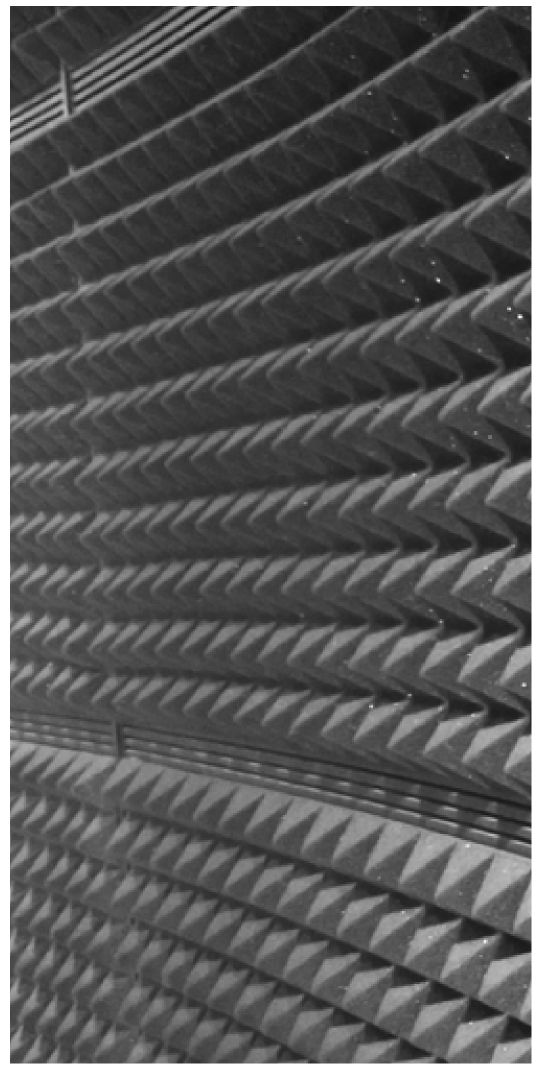
$i = 0 + r$ $\qquad \alpha = \frac{0}{i} =$

An open window can be said to have a = 1, all sound from the room which arrives at the window disappears out!

In hard materials, such as concrete or marble surfaces, virtually no sound energy is absorbed, everything is reflected and the a value is near to zero. In rooms with hard surfaces, the sound bounces for a long time before it dies out. The room has a long reverberation time and we get a strong, unpleasant echo. The sound level caused by normal sound sources becomes high.

In soft materials, such as thick mineral wool boards, the opposite happens. The a value is close to 1. Sometimes, excessively damped, soft rooms are unsuitable "You can't hear what you say". Avoid extremes - the reverberation time in a room should be chosen to suit the activities there.



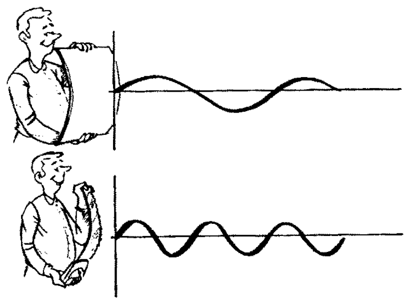
## Frequency and Wavelengths

As we see in the tables above, the damping ability varies with the frequency of sound. It could be a good idea to describe the concept of frequency in greater detail.

A sound source influences the surrounding air, and makes it vibrate. The character of the sound depends on the variations in pressure which occur in the air.

Let us assume that the sound source is a vibrating plate - the changes in pressure, or the sound will then have the same frequency as the vibrations in the plate. The strength of the sound will depend on the amount that the plate vibrates, i.e. the amplitude of the movement. Let us start off with that:

If there is only one note, of a single frequency, the pressure will vary sinusoidally, so a pure note is referred to as a sine wave.



The characteristics of sound propagation are:

- frequency (f), which is measured in Hertz, **Hz**, (s-1), (and specifies the number of times a second that a new sound wave arrives).
- wave length ($\lambda$, "lambda"), which is measured in metres, **m**, (and specifies the distance between two similar points on the curve).
- speed of sound (c) which is measured in m/s, (and specifies the speed of movement of the sound wave).

These three variables have the following relationship:

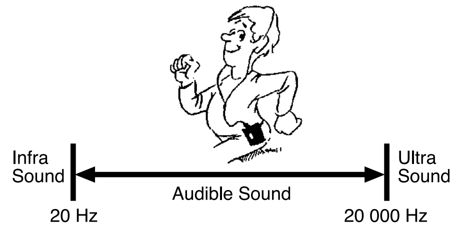
**$c = f \cdot \lambda$**

The speed of sound in air is also a function of pressure and temperature.

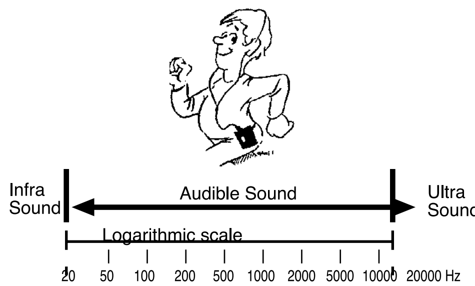
At normal air pressure and + 20°C:

c ≈ 340m/s.

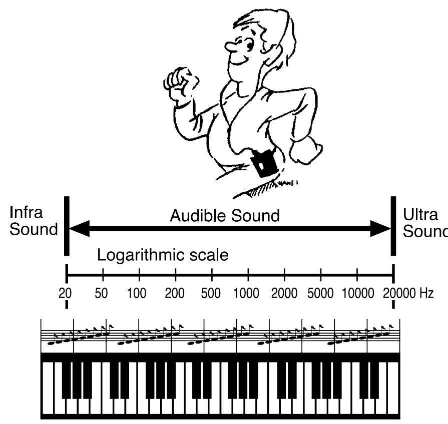
A young person with normal hearing can hear sounds at frequencies from 20-20 000 Hz, i.e. (in air) at wavelengths ranging from 17 m (at 20 Hz) to app. 17mm (at 20 kHz).




We perceive changes in sound frequency on a logarithmic scale, i.e. it is the relative frequency and not the difference in Hz which determines how a change in note is perceived. A doubling of frequency is perceived as being the same, irrespective of whether it is a change from 100 to 200 Hz, 1000 to 2000 Hz or 10 to 20 kHz.




The logarithmic scale is usually sub-divided into octaves. i.e. in scales where the top note is twice the frequency of the bottom note. This has been customary in music for a long time.



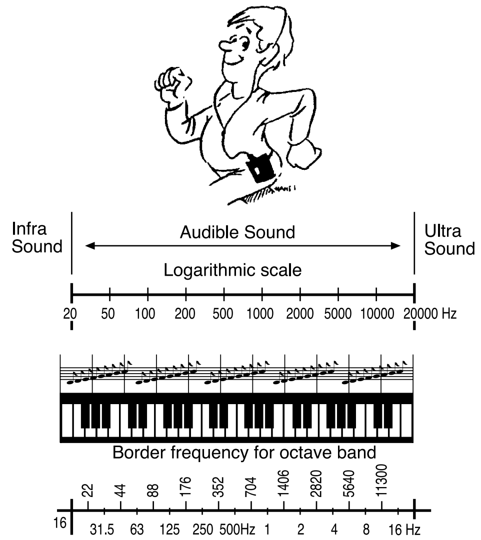






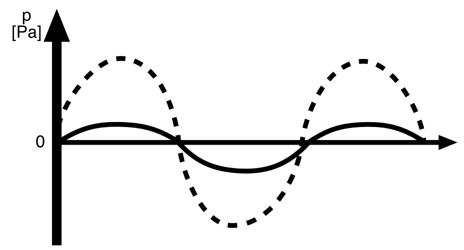


## Frequency and Wavelengths




**The Concept of Decibel**

The stronger the sound is, the harder the particles of air will bump into each other




Sound pressure changes in the audible area can vary within very wide limits. Some sounds are so weak that we can not hear them. The so-called audible limit varies with frequency and is 20 mPa at about 1000 Hz.

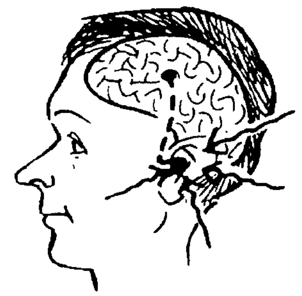
Other sounds are so loud that we risk hearing damage. The pain limit, the sound pressure which causes pain in your ears also varies with frequency, but is about 20 Pa at 1000 Hz. This means that it is a million times louder than the weakest sound we can perceive.

We also perceive changes in sound pressure on a logarithmic scale. A sound level concept using the decibel (dB) as the unit, has been created to express comparable values.

The **dB** unit, which is used in many different applications, is generally defined as: $10 \cdot \log (X/X_0)$, where X is the unit measured, i.e. the sound pressure, and X0 is a reference level expressed in the same units. The reletionship of X/X0 is thus dimensionless. The reference level from which the dB unit is specified, is given instead. This means that you generally express the level in dB (above $X_0$).

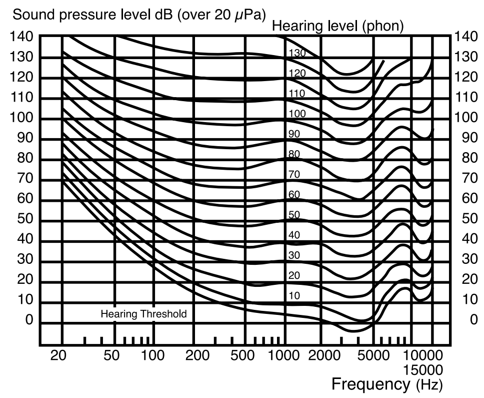
**Our Perception of Sound**

We react differently to two sounds which have the same sound pressure level and different frequencies.



Curves which describe how people normally perceive sounds of varying strength and frequency have been constructed through experiments on large numbers of volunteers. These so-called hearing level curves are designated by the sound pressure level for each curve at a frequency of 1 kHz. The unit used for the curves is the phon.

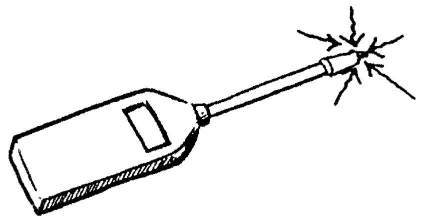
### Hearing Level Curves



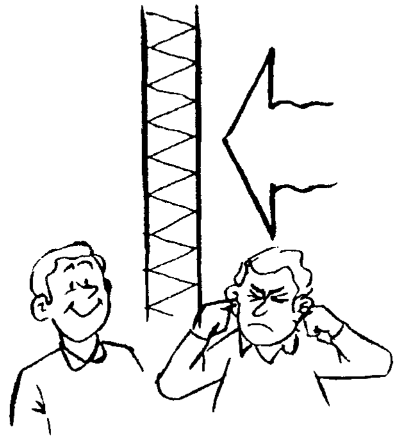

**Example:**

The sound pressure level 70 dB at 50 Hz is normally perceived as being as loud as 50 dB at 1000 Hz.

## Sound Levels

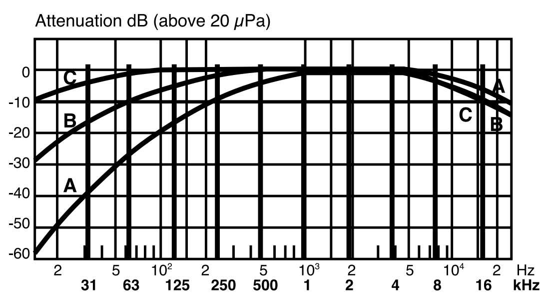


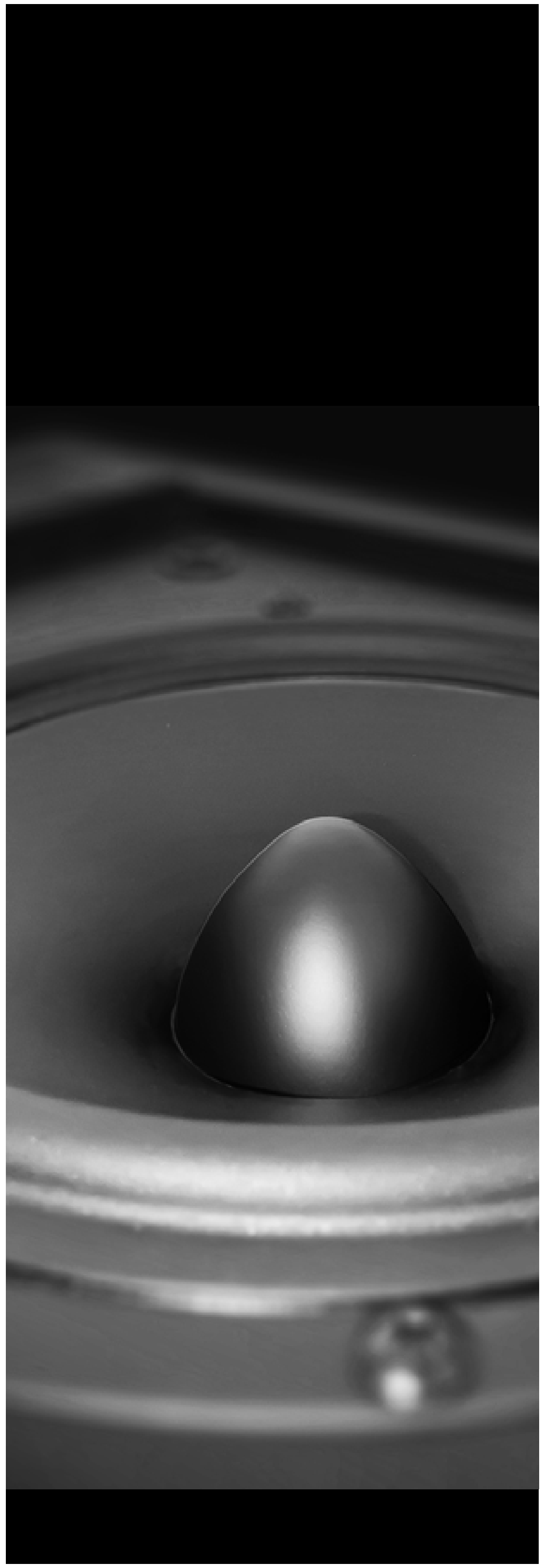
Several methods are used to compare the disturbance caused by two different sounds, and where the perception of the ear to noise has been modelled.



The simplest way is to compare their "weighted" sound levels. The incoming sound is filtered in an electronic filter to reduce the components, mostly the low-frequency components, where the ear is not so sensitive, and amplify the components between 1 and 4 kHz, where we are most sensitive.

Sound meters usually have three electronic filters, A-, B- and C-filter. The A-filter is mostly used these days, where the result, the "weighted" sound level, is expressed in dB (A).











## Sound

Sound is such a common part of everyday life that we rarely appreciated all of its functions. It provides enjoyable experiences such as listening to music or to the singing of birds. It enables spoken communication and it can alter of warn us - for example, with the ringing of a telephone, or a wailing siren. Sound also permits us to make quality evaluations and diagnoses - the chattering valves of a car, a squeaking wheel, or a heart murmur.

## Sound and Noise

Yet, too often in our modern society, sound annoys us. Many sounds are unpleasant or unwanted - these are called noise. However, the level of annoyance depends not only on the quality of the sound, but also our attitude towards it.

For example the type of music enjoyed by some people could be regarded as noise by others, especially if it is loud. But sound doesn't need to be loud to annoy. A creaking floor, a scratch on a record, or the intermittent sound of a dripping tap can be just as annoying as loud thunder. The judgement of loudness will also depend on the time of the day. For example, a higher level of noise will be tolerated during the day than at night.

## Good Acoustic Design

Adequate noise control in a duct system is not difficult to achieve during the design of the system, providing the basic noise control principles are understood. Despite the addition of noise control items in more and more building designs, complaints about HVAC system noise are still common. Investigations into noise complaints by acoustical professionals have found that, in many cases, the correct equipment and materials were used, but they were not properly integrated into a quiet system.

Virtually every survey on building comfort finds that excessive HVAC system noise levels are responsible for more complaints than any other aspect of the building environment. To minimize the possibility that design decisions could cause noise problems, the design team must consider the acoustical impacts of all design decisions, whether they are part of the schematics, design development, working drawings, or construction administration phases of the project.

Therefore, noise control design should begin during the schematic and design development phases and continue throughout the entire design process.

## Noise Control Principles

There are three distinct stages to the noise control process:

1. Source.
2. Transmission.
3. Reception

Noise control problem involves examining the noise sources,( fan noise, duct noise, diffuser noise, and building noise) the sound transmission paths, and the receivers. For most HVAC systems, the sound sources are associated with the building mechanical and electrical equipment.

Noise travels from the source to the receiver through many possible sound transmission paths,(structure-borne path through floor, airborne path through supply air system, duct breakout from supply air duct, airborne path through return air system, and airborne path through mechanical equipment room wall). Sound sources are the components that either generate noise, like electric motors, or produced noise when air passes by them, like dampers or diffusers. Sound receivers are generally the occupant of the building.

The noise control engineers are most often constrained to modifying the sound transmission paths as a mean of achieving the desired sound levels in occupied areas of a building.

## Definitions

**Attenuation**
The reduction of sound level per unit distance by divergence, diffusion, absorption, or scattering.

**A-weighted Sound Level**
The sound level measured using the A-weighting network of a sound level meter. For broadband sounds, the A-weighted sound level indicates approximate relative loudness.

**Background Noise**
It is the irreducible noise level measured in the absence of any building occupants when all of known sound sources have been turned off.

**Breakout Noise**
The transmission of fan or air system noise through duct walls.

**Criteria**
Noise levels which are subjectively or objectively acceptable in a given environment. The most commonly used criteria are Noise Criteria Curves (NC Levels), Noise Rating Curves(NR Levels) and dB(A).

**Decibel (dB)**
Commonly, the unit used to measure sound. It is used to quantify both sound pressure level and sound power level.

**Direct SPL**
Noise which is transmitted directly from a source (i.e. a grille or diffuser) without reflection.

**Ductborne Noise**
Noise which is transmitted along ductwork, both upstream and downstream of fan.

**Flanking Noise (Breakout)**
Noise transmitted through a barrier, often a fan casing or ductwork. Any indirect noise path which tends to devalue noise control measures used to reduce tansmission along the more obvious paths.

**Frequency (Hz.)**
The pitch of sound. The number of sound pressure waves arriving at a fixed point per second.

**Insertion Loss**
A measure of the noise reduction capability of an attenuator (sometimes of a partition) so named. After the method of testing where a section of ductwork is replaced by an attenuator between two test rooms. One room contains the noise source and the other the sound level measuring equipment. The difference in recorded noise level is said to be the insertion loss due to the insertion of the attenuator in the system.

**Noise Outlet**
Usually a grille or a diffuser. Any opening acting as a terminal element on either an extract or supply system.

**Octave Bands**
Subdivisions of the frequency range each identified by its mid (or centre) frequency. By international agreements these comprise 63, 125, 250, 500, 1k, 4k, and 8k Hz. and sometimes 31.5 Hz.

**Regenerated Noise**
Noise in addition to that produced by the fan, caused by air passing over fixed duct elements such as blades on grilles, dampers, air turns, splitters in attenuators, etc.

**Reverberant SPL**
Noise which is transmitted by reflection off room surfaces.

**Reverberant Time**
A measurement of the acoustic “reflectiveness” of a room.

**Sound Power Level (SWL)**
A theoretical assessment of sound produced at source calculated from the measured sound pressure levels at known distances from the source under known acoustic conditions.A level which depends only on the source and is independent of the environment or location.The sound power level of a fan is therefore very useful information since any level quoted can be compared directly with data from any other manufacturer.

**Sound Pressure Level (SPL)**
A measured sound level which is an indication only of the noise produced at source since environmental factors such as reverberation and distance from the source have affected the meassurement. The sound pressure level of a fan is not very useful since environmental factors apparent when the unit was measured may or may not be present in the actual location of the plant.









## Acoustic Design Procedures

Good acoustical design requires broad cooperation in the areas of architecture, structural, mechanical, electrical engineering, and acoustics. Delaying the acoustical design until after the structural system design is essentially complete sometimes leaves the design team with little flexibility in selecting and locating cost-effective noise control equipment and materials.

In order to effectively deal with each of the different sound sources and related sound paths associated with an HVAC system, the following design procedures are suggested :

1. Determine the design goal for HVAC system noise for each critical area according to its use and construction. Use Table 14 to specify the desirable NC levels.

2. Relative to equipment that radiates sound directly into a room, select equipment that will be quiet enough to meet the desired design goal.

3. If central or roof-mounted mechanical equipment is used, complete an initial design and layout of the HVAC system, using acoustical treatment where it appears appropriate.

4. Starting at the fan, appropriately add the sound attenuations and sound power levels associated with the central fan, and duct elements between the central fan and the critical room to determine the corresponding sound pressure levels in the room. Be sure to investigate the supply and return air paths. Investigate possible duct sound breakout when central fans are adjacent to the critical room or roof-mounted fans are above the critical room.

5. If the mechanical equipment room is adjacent to the critical room, determine the sound pressure levels in the room associated with sound transmitted through the mechanical equipment room wall.

6. Add the sound pressure levels in the critical room that are associated with all of the sound paths between the mechanical equipment room or roof-mounted unit and the critical room.

7. Determine the corresponding NC level associated with the calculated total sound pressure levels in the critical room.

8. If the NC level exceeds the design goal, determine the octave frequency bands in which the corresponding sound pressure levels are exceeded and the sound paths that are associated with these octave frequency bands.

9. Redesign the system, adding additional sound attenuation to the paths which contribute to the excessive sound pressure levels in the critical room.
10. Repeat steps 4 through 9 until the desired design goal is achieved.

11. Steps 3 through 10 must be repeated for every room that is to be analyzed.

12. Make sure that noise radiated by outdoor equipment will not disturb adjacent properties.

13. With respect to outdoor equipment, use barriers when noise associated with the equipment will disturb adjacent properties.

14. If mechanical equipment is located on upper floors or is roof-mounted, vibration isolate all reciprocating and rotating equipment. It may be necessary to vibration isolate mechanical equipment that is located in the basement of the building.

A sound analysis should be carried out starting from the fan or noise source having ducted connections to the room of interest.

It is strongly recommend that sound level requirements for NC 30 or below be calculated out by SAFID so as to ensure a complete check against noise criteria levels.

### Fan In-Duct Sound Power Level

Obtain from the fan manufacturer's catalogue information, or calculate the approximate In-duct Sound Power Level from Table 1.

In both case the approximate duty of the fan needs to be known.

These figures are inserted in line a.
Some manufacturers present noise data as a Sound Pressure Level which needs to be converted by applying the relevant correction factor.

### Duct System Between the Fan and the Critical Noise Outlet

Select the most critical noise outlet in the duct system, normally the noise outlet nearest to the fan, and estimate the sound power reduction which occurs along the duct path to this outlet and the outlet itself. Using the following information assess the total duct attenuation.

Straight unlined sheet metal ducts provide a degree of attenuation. This is frequency dependent and varies with the minimum duct dimension and duct length. Approximate attenuation of straigth unlined rectangular sheet metal ducts per meter run is shown in Table 2.

To avoid noise breakout problems in the duct attenuation taken should be limited to approximately 15dB.

Circular sheet metal duct attenuation shown in Table 3. Bends provide attenuation as shown in Tables 4 and 5. Duct and bend attenuation figures should be entered against lines b.

At low frequencies some of the sound power on reaching the critical noise outlet is reflected back along the duct. The degree of attenuation due to this phenomenon is dependent on frequency and the total area of the outlet. The attenuation from Table 6 is inserted in line c.

The Sound Power Level leaving the critical outlet is obtained from e=a-(b+c)

### Calculate the Room Effect

In a room the sound pressure waves will reach the listener along two paths:

1. Directly, reducing as the (distance)2 from the noise source, known as the Direct Sound Pressure Level.

2. By multiple reflections off the room surfaces and room contents, which will depend upon the size of the room and the reverberation time, known as the Reverberant Sound Pressure Level.

To estimate the Direct Sound Pressure Level.

Calculate the percentage of the total sound leaving the critical noise outlet. This is approximately equal to the percentage of the fan air volume which passes through the critical outlet.

Table 7 gives the factors to be inserted in line f.

Estimate the distance between the nearest listening position and the critical outlet, and using Table 8, insert the distance factors in line g. Unless the specification states otherwise, the commonly applied distance is 1.5 meters.

By examining the position of the nearest outlet in relation to the walls and ceiling of the room will affect the resultant sound pressure level, due to directivity. Select the location type (A, B, or C) using Table 9, which is closest to matching the position of the critical outlet in the room.

Using the charts for the chosen location type and outlet area, insert the factors obtained in line h.

The Direct Sound Pressure Level in the room in line i is equal to the sum of the Sound Power Level leaving the Critical Outlet in line e and lines f g h.

**To estimate the Reverberant Sound Pressure Level.**

For the fan system in question, Calculate the percentage of the sound emerging from all the noise outlets in the room served by the fan.

This approximates to the percentage of the fan air volume serving the room under investigation.

Using Table 10 insert the factor in line k.









The amount of reflection or absorption of the sound emerging from the noise outlets depends upon the volume and the reverberation time (which is a function of the amount of absorption) of the room. Table 11 and 12 give the factors related to these which are inserted in lines l and m respectively.

The factors tabulated at each Octave Band in lines k,l and m are now added together to give the Total Reverberant Factors.

The Reverberant sound Pressure level (line o) in the room is equal to the sum of the Sound Power Level leaving the Critical Outlet (line e) and the Total Reverberant Factors (lines k + l + m).

To arrive at the Combined Sound Pressure Level, it is necessary to logarithmically sum the Reverberant Sound Pressure Level and the Direct Sound Pressure Level. This can be simplified by using Table 13. The combined pressure level can then be entered in line p.

### Required Insertion Loss

The specification will usually give a design criteria for various area function; where one is not given, Table 14 can be used.

The required or selected criterion is inserted in line q.

If the Combined Sound Pressure Level exceeds the Criterion in any Octave Band, then the difference is the Insertion Loss required from the attenuator (line r).

To allow the possible addition of noise from other sources a safety margin of typically 3dB may be added.

The attenuator can now be selected to meet the parameters of insertion loss, physical size and the pressure loss. The Insertion Loss figures are placed in line s as a final check.

The above analysis method takes no account of regenerated noise from attenuators or ductwork elements.

Similarly, it is not possible to deal with the method of selecting attenuators for high pressure systems which commonly have terminal devices that generate noise and often have some attenuation capability

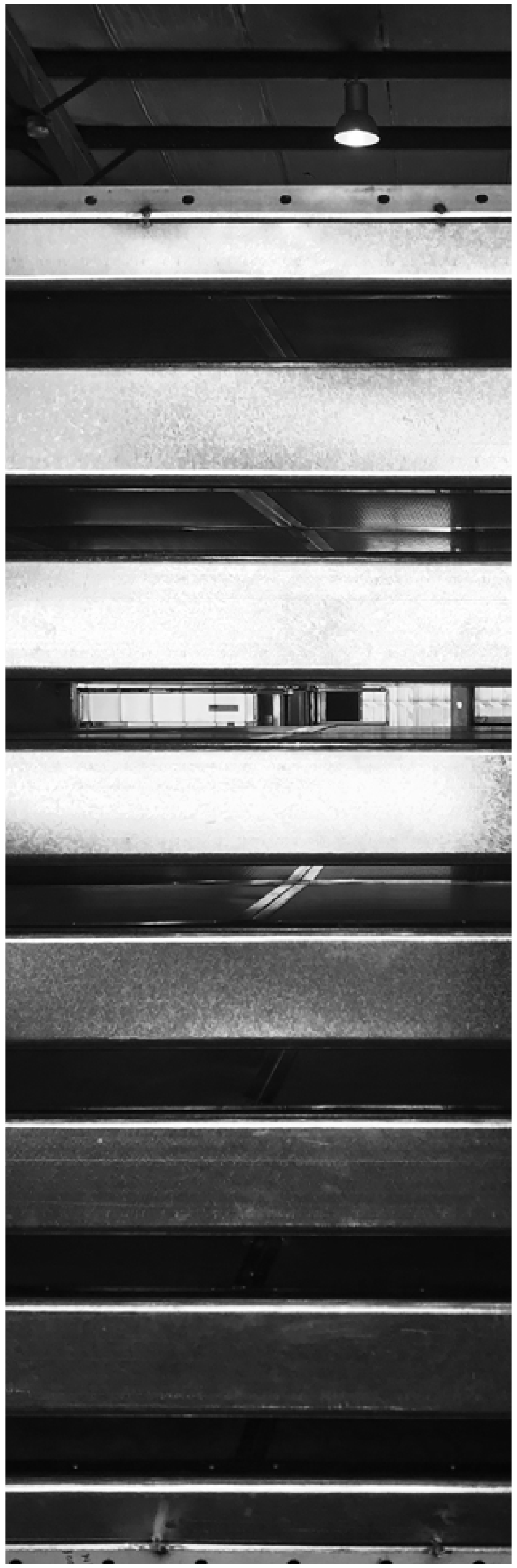


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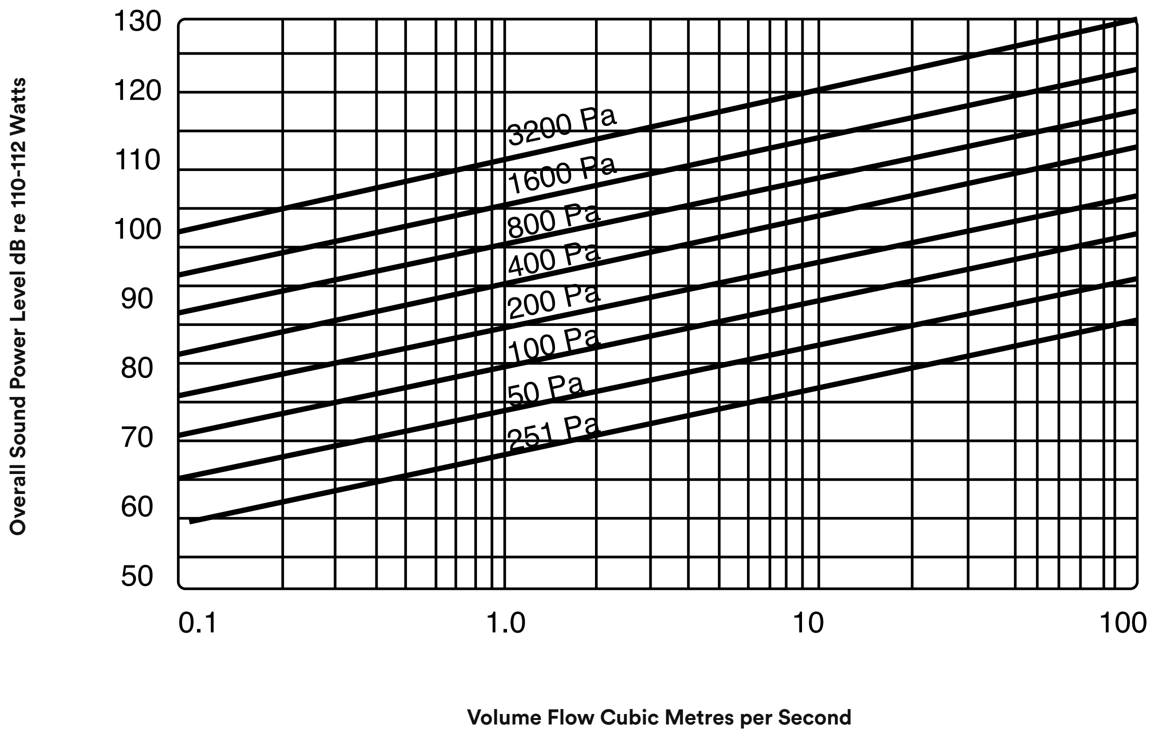
**Table 1: In-Duct SWL of the Fan**




**Spectrum Correction**

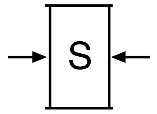
| | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 200 | 500 | 1k | 2k | 4k | 8k |
| Forward Curved Centrifugal | -2 | -7 | -12 | -17 | -22 | -27 | -32 | -37 |
| Backward Curved Centrifugal | -7 | -8 | -7 | -12 | -17 | -22 | -27 | -32 |
| Axial | -5 | -5 | -6 | -7 | -8 | -8 | -14 | -17 |





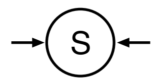


**Table 2: Attenuation of Straight Unlined Rectangular Sheet Metal Ducts - (dB/m)**



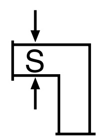

| Min. Duct Dimension S (mm) | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 000 - 200 | 0.6 | 0.6 | 0.45 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 201 - 400 | 0.6 | 0.6 | 0.45 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| 401 - 800 | 0.6 | 0.6 | 0.3 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| 801 - 1600 | 0.3 | 0.15 | 0.15 | 0.1 | 0.06 | 0.06 | 0.06 | 0.06 |

**Table 3: Attenuation of Straight Unlined Circular or Round Sheet Metal Ducts - (dB/m)**



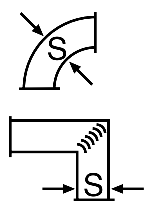

| Min. Duct Dimension S (mm) | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 000 - 180 | 0.03 | 0.03 | 0.05 | 0.05 | 0.1 | 0.1 | 0.1 | 0.1 |
| 181 - 380 | 0.03 | 0.03 | 0.03 | 0.05 | 0.07 | 0.07 | 0.07 | 0.07 |
| 381 - 760 | 0.02 | 0.02 | 0.02 | 0.03 | 0.05 | 0.05 | 0.05 | 0.05 |
| 761 - 1520 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |

**Table 4: Attenuation of Mitred Bends Without Turning Vanes or with Short Chord Turning Vanes (Rectangular Ducts) - dB**




| Min. Duct Dimension S (mm) | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 000 - 200 | 0 | 0 | 0 | 0 | 6 | 8 | 4 | 3 |
| 201 - 400 | 0 | 0 | 0 | 6 | 8 | 4 | 3 | 3 |
| 401 - 800 | 0 | 0 | 6 | 8 | 4 | 3 | 3 | 3 |
| 801 - 2000 | 0 | 6 | 8 | 4 | 3 | 3 | 3 | 3 |

**Table 5: Attenuation of Radiussed Bends or Mitred Bends with Long Chord Turning Vanes (Circular or Rectangular Ducts) - dB**




| Min. Duct Dimension S (mm) | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 000 - 250 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 3 |
| 251 - 500 | 0 | 0 | 0 | 1 | 2 | 3 | 3 | 3 |
| 501 - 1000 | 0 | 0 | 1 | 2 | 3 | 3 | 3 | 3 |
| 1001 - 2000 | 0 | 1 | 2 | 3 | 3 | 3 | 3 | 3 |







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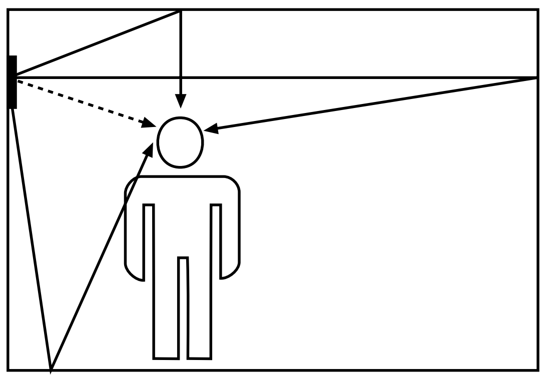
**Table 6: Outlet Reflection (dB)**

| Outlet Area -cm² | Octave Centre Frequency ($f_m$ in Hz) 63 | 125 | 250 | 500 | 1k |
|---|---|---|---|---|---|
| | 20 | 15 | 10 | 6 | 3 |
| 100 | 19 | 14 | 9 | 5 | 2 |
| | 18 | 13 | 8 | 4 | 1 |
| | 17 | 12 | 7 | 3 | 0 |
| | 16 | 11 | 6 | 2 | |
| | 15 | 10 | 5 | 1 | |
| 500 | 14 | 9 | 4 | 0 | |
| | 13 | 8 | 3 | | |
| | 12 | 7 | 2 | | |
| 1000 | 11 | 6 | 1 | | |
| | 10 | 5 | 0 | | |
| | 9 | 4 | | | |
| | 8 | 3 | | | |
| | 7 | 2 | | | |
| 5000 | 6 | 1 | | | |
| | 5 | | | | |
| 10000 | 4 | | | | |



Direct

Reverberant

**Table 7 : Percentage of Total Sound Factors (dB)**

| dB | % |
|---|---|
| -20 | 1% |
| -19 | |
| -18 | |
| -17 | 2 |
| -16 | |
| -15 | 3 |
| -14 | 4 |
| -13 | 5 |
| -12 | |
| -11 | |
| -10 | 10 |
| -9 | |
| -8 | |
| -7 | 20 |
| -6 | |
| -5 | |
| -4 | |
| -3 | 50 |
| -2 | |
| -1 | |
| 0 | 100 |

**Table 8 : Distance Factors (dB)**

| dB | Distance |
|---|---|
| -10 | |
| -11 | 1 meters |
| -12 | |
| -13 | |
| -14 | 1.5 |
| -15 | |
| -16 | |
| -17 | 2 |
| -18 | |
| -19 | |
| -20 | 3 |
| -21 | |
| -22 | |
| -23 | 4 |
| -24 | |
| -25 | 5 |
| -26 | 6 |
| -27 | |
| -28 | 7 |
| -29 | 8 |
| -30 | 9 |







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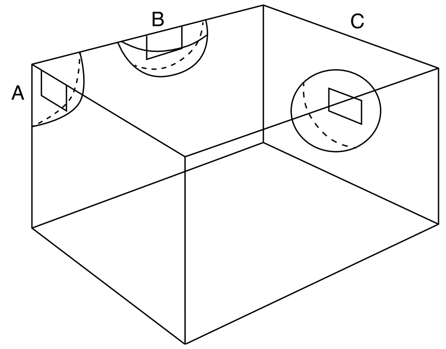
**Table 9: Directivity Factor (dB)**




Type B — Junction of Two Room Surfaces

Outlet Area (cm²): 10, 100, 1000, 10000

| Octave Centre Frequency (Hz) | | | | |
|---|---|---|---|---|
| 63 | +6 | +7 | +8 | |
| 125 | +6 | +7 | +8 | |
| 250 | +6 | +7 | +8 | +9 |
| 500 | +6 | +7 | +8 | +9 |
| 1k | +7 | +8 | +9 | |
| 2k | +7 | +8 | +9 | |
| 4k | +7 | +8 | +9 | |
| 8k | +8 | +9 | | |

Type C — Junction of Two Room Surfaces

Outlet Area (cm²): 10, 100, 1000, 10000, 100000

| Octave Centre Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 63 | +3 | +4 | +5 | +6 | +7 | | |
| 125 | +3 | +4 | +5 | +6 | +7 | +8 | |
| 250 | +3 | +4 | +5 | +6 | +7 | +8 | +9 |
| 500 | +3 | +4 | +5 | +6 | +7 | +8 | +9 |
| 1k | +4 | +5 | +6 | +7 | +8 | +9 | |
| 2k | +5 | +6 | +7 | +8 | +9 | | |
| 4k | +7 | +8 | +9 | | | | |
| 8k | +8 | +9 | | | | | |

**Table 10: Percentage of Total Sound Factors (dB)**

| dB | % |
|---|---|
| -20 | 1% |
| -19 | |
| -18 | |
| -17 | 2 |
| -16 | |
| -15 | 3 |
| -14 | 4 |
| -13 | 5 |
| -12 | |
| -11 | |
| -10 | 10 |
| -9 | |
| -8 | |
| -7 | 20 |
| -6 | |
| -5 | |
| -4 | |
| -3 | 50 |
| -2 | |
| -1 | |
| 0 | 100 |

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Table 11: Room Volume Factor (dB)

| | |
|---|---|
| +10 | |
| +9 | 3 |
| +8 | |
| +7 | 5 |
| +6 | |
| +5 | |
| +4 | 10 |
| +3 | |
| +2 | |
| +1 | 20 |
| 0 | |
| -1 | |
| -2 | |
| -3 | 50 |
| -4 | |
| -5 | |
| -6 | 100 |
| -7 | |
| -8 | |
| -9 | 200 |
| -10 | |
| -11 | |
| -12 | |
| -13 | 500 |
| -14 | |
| -15 | |
| -16 | 1000 |
| -17 | |
| -18 | |
| -19 | 2000 |
| -20 | |
| -21 | |
| -22 | |
| -23 | 5000 |
| -24 | |
| -25 | |
| -26 | 10000 |
| -27 | |
| -28 | |

Table 12: Reverbation Time Factors (dB)

| | |
|---|---|
| -11 | |
| -10 | |
| -9 | |
| -8 | |
| -7 | |
| -6 | |
| -5 | |
| -4 | Average Furnishing |
| -3 | Average Furnishing |
| -2 | Average Furnishing |
| -1 | Limited Furnishing |
| 0 | Limited Furnishing |
| +1 | Limited Furnishing |
| +2 | No Furnishing |
| +3 | No Furnishing |
| +4 | No Furnishing |
| +5 | Very Hard Surface High Ceilings |
| +6 | Very Hard Surface High Ceilings |
| +7 | Very Hard Surface High Ceilings |
| +8 | |
| +9 | |
| +10 | |
| +11 | |

Table 13: Addition of Sound Pressure Levels (dB)

| Difference in SPLs | Add to larger SPL |
|---|---|
| 0 to 1 | +3 |
| 2 to 3 | +2 |
| 4 to 9 | +1 |
| 10 and above | +0 |

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Table 14: Recommended Design Criteria for Various Area Functions

| Situation | NC |
|---|---|
| **Section 1 - Studios and Auditoria** | |
| Sound Broadcasting (drama) | 15 |
| Sound Broadcasting (general), TV (general), Recording Studio | 20 |
| TV (audience studio) | 25 |
| Concert Hall, Theatre | 20 - 25 |
| Lecture Theatre, Cinema | 25 - 30 |
| **Section 2 - Hospitals** | |
| Audiometric Room | 20 - 25 |
| Operating Theatre, Single Bed Ward | 30 - 35 |
| Multi-bed Ward, Waiting room | 35 |
| Corridor, Laboratory | 35 - 40 |
| Wash Room, Toilet, Kitchen | 35 - 45 |
| Staff Room, Recreation Room | 30 - 40 |
| **Section 3 - Hotels** | |
| Individual Room, Suite | 20 - 30 |
| Ballroom, Banquet Room | 30 - 35 |
| Corridor, Lobby | 35 - 40 |
| Kitchen, Laundry | 40 -45 |
| **Section 4 - Restaurants, Shops and Stores** | |
| Restaurant, Department Store (upper floor) | 35 - 40 |
| Club, Public House, Cafeteria, Canteen, Retail Store (main floor) | 40 - 45 |
| **Section 5 - Offices** | |
| Boardroom, Large Conference Room | 25 - 30 |
| Small Conference Room, Executive Office, Reception Room | 30 - 35 |
| Open Plan Office | 35 |
| Drawing Office, Computer Suite | 35 - 45 |
| **Section 6 - Public Buildings** | |
| Court Room | 25 - 30 |
| Assembly Hall | 25 - 35 |
| Library, Bank, Museum | 30 - 35 |
| Wash Room, Toilet | 35 - 45 |
| Swimming Pool, Sports Arena | 40 - 50 |
| Garage, Car Park | 55 |
| **Section 7 - Ecclesiastical and Academic Buildings** | |
| Church, Mosque | 25 - 30 |
| Classroom, Lecture Theatre | 25 - 35 |
| Laboratory, Workshop | 35 - 40 |
| Corridor, Gymnasium | 35 - 45 |
| **Section 8 - Industrial** | |
| Warehouse, Garage | 45 - 50 |
| Workshop (light engineering) | 45 - 55 |
| Workshop (heavy engineering) | 50 - 65 |
| **Section 9 - Private Dwelling (Urban)** | |
| Bedroom | 25 |
| Living Room | 30 |

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## Calculation Sheet

### SAFID Acoustics

Project:

Client:

Contractor:

Engineer:

**Roomside Analysis Calculations**

Date:

Building:

Equipment No:

Offer No:

Total Air Flow ($M^3/s$)

Source Sound power Level

| | | | | | Octave Centre Frequency 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source Sound power Level | | | | | | | | | | | | |
| Smallest Ducts Dimension (mm) | | Length (mm) | | - | | | | | | | | |
| Radiussed Elbows Width (mm) | | Qty. | | - | | | | | | | | |
| Additional Attenuation | | | | - | | | | | | | | |
| Outlet Reflection | Length (cm) | Width (cm) | | - | | | | | | | | |

### SWL Leaving System

| | | | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage Leaving Outlet | $M^3/s$ | | | - | | | | | | | | |
| Distance from Outlet to Listener (m) | | | | - | | | | | | | | |
| Directivity | | Centre of Wall or Ceiling | | + | | | | | | | | |

### Direct SPL

| | | | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage Leaving Outlet | $M^3/s$ | | | - | | | | | | | | |
| Room Volume | Length x Width ($m^2$) | Height (m) | | - | | | | | | | | |
| Reverbation Time | | Seconds | | + | | | | | | | | |

### Reverberant SPL

### Combined SPL

| | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|---|---|
| Criterion NC / NR / dBA | | NC | 57 | 48 | 41 | 35 | 31 | 29 | 28 | 27 |
| Add dB Safety Factor | | | | | | | | | | |

### Required Insertion Loss

Required Insertion Losses dB

Selected Insertion Losses dB

Air Generated Sound Power Level

| Octave Centre Frequency | | | | | | | |
|---|---|---|---|---|---|---|---|
| 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| | | | | | | | |



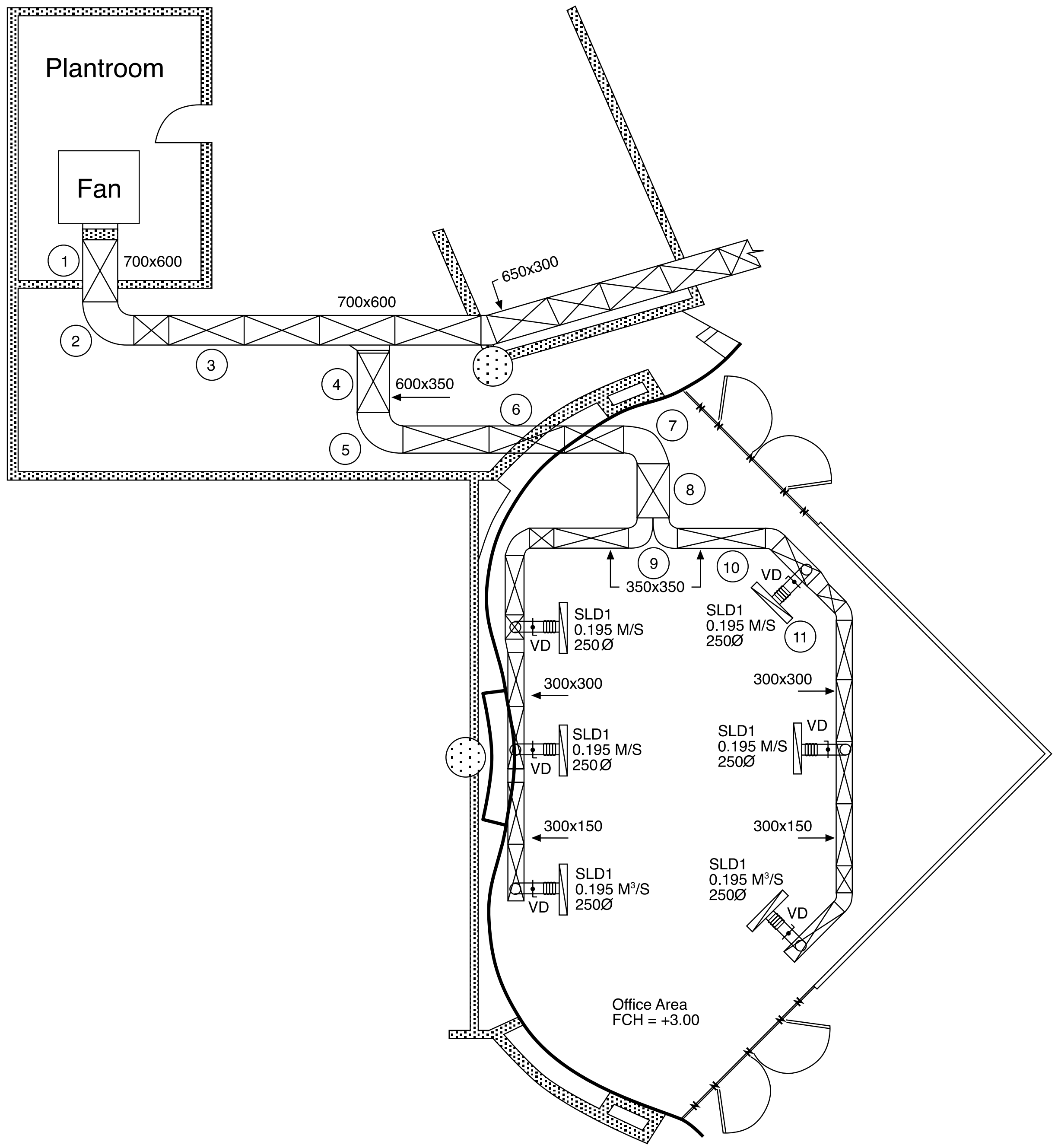






SAFID

## Figure 1 : Duct System For Fan Noise Calculation Example



## Calculation Example

The simple duct system shown in figure 1 will be entered on the calculation sheet to show the steps to be followed to determine whether sound attenuating materials are required to reduce the fan noise in a duct system.

For the duct system described in Figure 1, the sound power level produced by the fan is known from manufacturer's data. Calculate the sound pressure level in office area, at the nearest occupied position to a supply ceiling slot linear diffuser, which is given to be 1.5 meters from the diffuser and directly in line with its axis, and the diffusers are located in the ceiling.

### Fan Details

**Type :** Centrifugal
**Duty :** 2.26 m3/s at 600 Pa.
Sound Power Level at mid frequency Octave Bands

| Hz | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|
| dB | 86 | 91 | 87 | 92 | 88 | 88 | 82 | 74 |

### Room Details

**Room Value :** 300 m³
**Room Height :** 3m
**Outlet : :** Slot diffuser with 30mm neck width, 1200mm long. Slot diffuser handles 0.195 m³/s.

### Room Criterion

NC 35 at 1.5 metres from the noise outlet.
Office area

## Roomside Calculation

### System Element

| Ref | Type | W | H | Length / Type |
|---|---|---|---|---|
| 1 | Duct | 700 | 600 | 2 meters |
| 2 | Bend | 700 | 600 | Radiused |
| 3 | Duct | 700 | 600 | 5 meters |
| 4 | Duct | 600 | 350 | 2 meters |
| 5 | Bend | 600 | 350 | Radiused |
| 6 | Duct | 600 | 350 | 6 meters |
| 7 | Bend | 600 | 350 | Radiused |
| 8 | Duct | 600 | 350 | 2 meters |
| 9 | Bend | 350 | 350 | Radiused |
| 10 | Duct | 350 | 350 | 2 meters |
| 11 | Outlet | 2 slot diffuser, 30 mm neck width 1200 mm long | | |







## Calculation Example

### SAFID Acoustics

Project:
Client:
Contractor:
Engineer:

**Roomside Analysis Calculations**
Date:
Building:
Equipment No:
Offer No:

**Total Air Flow ($M^3$/s)** 2.26

**Source Sound power Level**

| Smallest Ducts Dimension (mm) | Length (mm) |
|---|---|
| 600 | 7 |
| 350 | 12 |

| Radiussed Elbows Width (mm) | Qty. |
|---|---|
| 700 | 1 |
| 600 | 2 |
| 350 | 1 |

**Additional Attenuation**

| Outlet Reflection | Length (cm) | 120 | Width (cm) | 3 |
|---|---|---|---|---|

**SWL Leaving System {a-(b+c)}**

| Percentage Leaving Outlet | $M^3$/s | 0.195 | 9% |
|---|---|---|---|
| Distance from Outlet to Listener (m) | | 1.5 | |
| Directivity | | | Centre of Wall or Ceiling |

**Direct SPL {e-(f+g)+h}**

| Percentage Leaving Outlet | $M^3$/s | 1.17 | 52% | |
|---|---|---|---|---|
| Room Volume | Length x Width ($m^2$) | 100 | Height (m) | 3 |
| Reverbation Time | | | 1 Second | |

**Reverberant SPL {e-(k+l)+m}**

**Combined SPL (logarithmic addition of i an o)**

| Criterion NC / NR / dBA | | NC 35 |
|---|---|---|
| Add dB Safety Factor | 3 | |

**Required Insertion Loss**

| | | Octave Centre Frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Source Sound power Level | | 86 | 91 | 87 | 92 | 88 | 88 | 82 | 74 | a |
| Smallest Ducts Dimension | - | 4.2 | 4.2 | 2.1 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | b |
| | - | 7.2 | 7.2 | 5.4 | 3.6 | 2.4 | 2.4 | 2.4 | 2.4 | |
| Radiussed Elbows | - | | | 1 | 2 | 3 | 3 | 3 | 3 | b |
| | - | | | 2 | 4 | 6 | 6 | 6 | 6 | |
| | - | | | | 1 | 2 | 3 | 3 | 3 | |
| Additional Attenuation | - | | | | | | | | | b |
| Outlet Reflection | - | 15 | 10 | 6 | 2 | | | | | c |
| SWL Leaving System | | 60 | 70 | 71 | 78 | 74 | 73 | 67 | 59 | e |
| Percentage Leaving Outlet | - | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | f |
| Distance from Outlet to Listener | - | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | g |
| Directivity | + | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 8 | h |
| Direct SPL | | 38 | 49 | 51 | 59 | 56 | 56 | 50 | 42 | i |
| Percentage Leaving Outlet | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | k |
| Room Volume | - | -11 | -11 | -11 | -11 | -11 | -11 | -11 | -11 | l |
| Reverbation Time | + | | | | | | | | | m |
| Reverberant SPL | | 46 | 56 | 57 | 64 | 60 | 59 | 53 | 45 | o |
| Combined SPL | | 47 | 57 | 58 | 65 | 61 | 61 | 55 | 47 | p |
| Criterion NC / NR / dBA | | 60 | 52 | 45 | 40 | 36 | 34 | 33 | 32 | q |
| Add dB Safety Factor | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| Required Insertion Loss | | | 8 | 16 | 28 | 28 | 30 | 25 | 18 | r |

### Sound Attenuator Selection

SA / O / 20 - 150 O / 900L x 700W x 600H
Required Insertion Losses dB
Selected Insertion Losses dB
Attenuator Air Flow 2.26 M3/s
Attenuator Pressure drop 47 Pa

| Octave Centre Frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| | 8 | 16 | 28 | 28 | 30 | 25 | 18 | |
| 8 | 14 | 20 | 37 | 47 | 32 | 26 | 24 | s |

# INTRODUCTION TO SILENCERS

### General

SAFID attenuators were developed in response to various requirements from consulting engineers, owners and contractors. They provide the most economical choice for solving the wide range of noise control issues encountered in the HVAC field.

Our standard range of attenuators should cover most of the common problems in the HVAC industry, but if none of our standard silencers meet your requirements then we will develop one for your need.

### Material

All SAFID attenuator are constructed of galvanized steel sheets as per ASTM A924 and ASTM A653 (replacing ASTM A525/A527).

Attenuators are also available in the following materials:
- Stainless steel as per ASTM 240 type 304 or 316.
- Epoxy coated (internally and externally).

### Surface Finish

All SAFID galvanized attenuator are produced with G90 surface coating or 275g/m$^2$ zinc coating, regular spangle finish.

- All stainless steel attenuator are made with 2B mill finish.
- All epoxy coated attenuators are to be made to client requirements in terms of color and coating thickness.

### Acoustic Infill

All SAFID "Acoustic Infill" material is inert, non-flammable, non-hygroscopic, will not sustain vermin or fungus, rot proof and odorless. The "Acoustic Infill" shall be faced with glass tissue or equivalent. The infill material is guaranteed against erosion up to air velocities of 30 m/s and temperatures up to 121$^o$C.

The acoustic infill tested to the following tests:
- Surface Burinng Characteristics: UL 723, ASTM E84, ASTM E136
- Mold Growth: ASTM D2020, UL 181
- Moisture Absorption: ASTM D-07 B, ASTM C550
- Fire Resistance: NFPA 90A
- Acoustic Performance: ASTM C1071, ASTM C423-77

### Test Method

All SAFID attenuators are tested in accordance with BS 4718: 1971. "Methods of Test for silencers for Air Distribution Systems". These tests were carried out by the Sound Research Laboratories Limited in Sudbury, Suffolk, U.K.

The SRL Labs are equipped with the most up-to-date instruction and computer systems and able to conduct all acoustic and aerodynamic tests across the octave band frequency range 63Hz to 8KHz.

The laboratory measurement of insertion loss is defined as the arithmetic difference in the sound level of an electronically generated noise produced upstream of the test sample location with and without the test sample installed, when measured downstream of the test sample location.

The test ducting is assembled such that one end is located into a plenum containing the sound source and the outlet is fed into the 300 cubic metres reverberation room.

The static insertion loss is measured by placing a speaker in the duct and then measuring the noise levels in the test chamber with and without the attenuator. The difference between the measurements is calculated to give the insertion loss.

For the regenerated noise, measurements are made of the noise generated by air flowing through the duct system alone. Part of the duct work is then replaced by attenuator and the noise is measured again. The noise due to this system is then deducted from the noise measured with the attenuator to give the regenerated noise due solely to the attenuator.

From the above carried tests the insertion losses measurements have been recorded and derived and are presented in the tabular form in Table 17 of this section.







# RECTANGULAR SOUND ATTENUATOR

SA

### Description

The straight rectangular cased attenuator is mainly used to reduce fan and machine noise to meet the required or allowed noise levels. The SA attenuator offer many advanced features including as a standard aerodynamic splitters, side liners, slide on flange and protect acoustic infill by galvanized perforated sheet metal.

### Construction

Type SA attenuator casings and splitters are manufactured from galvanized sheet metal Ga.20 minimum. Casing are formed with lock formed seams with a mastic sealant; the construction complies with SMACNA and DW 144 Standards. SAF - 30 slide on flanges are fitted as standard.

The splitters contain acoustic infill which complies with Class O Building Regulations. The infill has a glass tissue facing and is contained behind galvanized perforated metal; this dual protection prevents damage and fibre erosion up to 30 m/s airway velocity. The splitters are radiussed at both ends to minimize air pressure loss and regenerated noise.

### Alternative Construction

**SAHP**
Type SAHP; as for type SA but with the casing thickness increased to Ga.18 to comply with ductwork codes SMACNA stds. high pressure & DW 144 Class C or D.

**SAM**
Type SAM; as for type SA but the acoustic infill is enveloped in a Melinex polyester film.

**SAH**
Type SAH; as for type SA but with horizontal splitters, normally to a maximum width dimension of 1200mm.

**SAAF**
Type SAAF; as for type SA but with rolled steel angle end flanges drilled to a standard pattern.

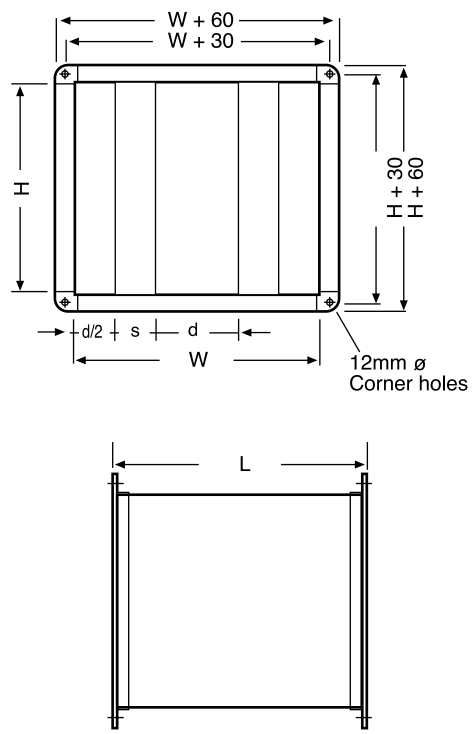
### Sectionalised Construction

SA attenuators are normally supplied in sections when any of the following dimensions are exceeded: W=2100mm, H=1800mm, L=2100mm.

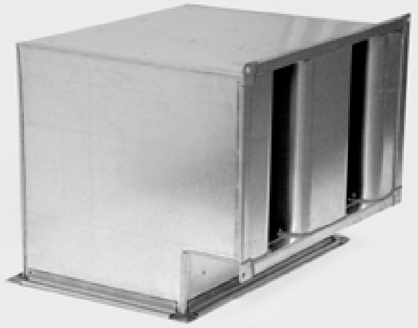
The assembly of sectionalised attenuators is on site, by others. SAFID will provide full details of attenuator configuration and assembly.

### Dimensions

Attenuator: Type SA



## SABV



### Description

The vertical-mounted cased bend rectangular attenuator is mainly used to reduce fan and machine noise to meet the required or allowed noise levels. The SA attenuator offer many advanced features including as a standard aerodynamic splitters, side liners, slide on flange and protect acoustic infill by galvanized perforated sheet metal.

### Construction

The construction of cased bend attenuators is generally as for the straight version. To minimize resistance to airflow, turning vanes are incorporated into the design.

Dimension L1 and L2 refer to the air entry and discharge legs respectively, measured along the center path of the bend until the intersection point so that Li + L2 will be equal to L. Unless requested otherwise, bend attenuators would be supplied with L1 equal to L2.

### Alternative Construction

**SABVP**
Type SABVP; as for type SABV but with the casing thickness increased to Ga.18 to comply with ductwork codes SMACNA stds. high pressure & DW 144 Class C or D.

**SABVM**
Type SAM; as for type SA but the acoustic infill is enveloped in a Melinex polyester film.

**SABVF**
Type SABVF; as for type SABV but with rolled steel angle end flanges drilled to a standard pattern.

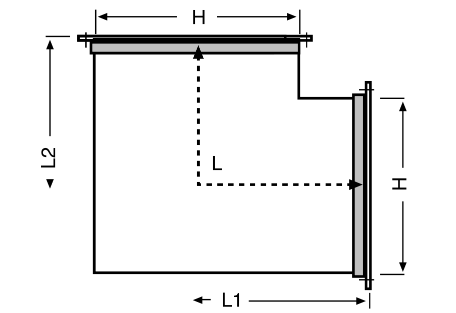
### Sectionalised Construction

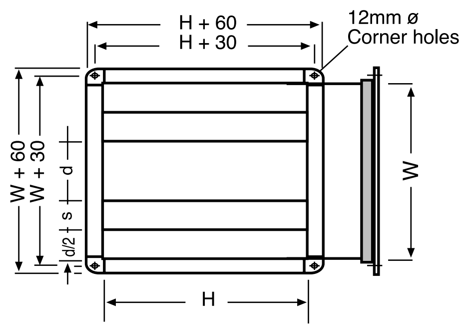
SABV attenuators are normally supplied in sections when any of the following dimensions are exceeded: W=2100mm, H=1800mm, L=2100mm

The assembly of sectionalised attenuators is on site, by others. SAFID will provide full details of attenuator configuration and assembly.

### Dimensions

Vertical Bend Attenuator: Type SABV



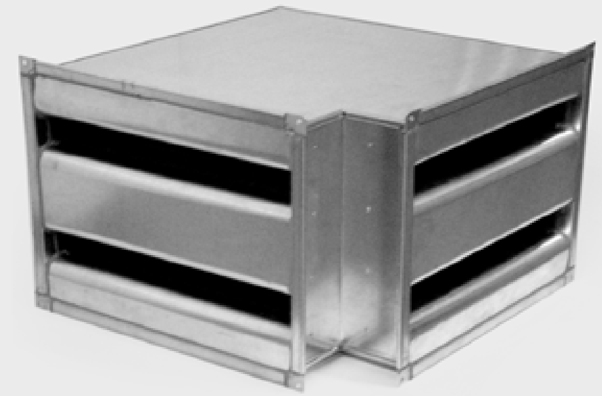








## SABH



### Description

The horizontal-mounted cased bend rectangular attenuator is mainly used to reduce fan and machine noise to meet the required or allowed noise levels. The SA attenuator offer many advanced features including as a standard aerodynamic splitters, side liners, slide on flange and protect acoustic infill by galvanized perforated sheet metal.

### Construction

The construction of cased bend attenuators is generally as for the straight version. To minimize resistance to airflow, turning vanes are incorporated into the design.

Dimension L1 and L2 refer to the air entry and discharge legs respectively, measured along the center path of the bend until the intersection point so that Li + L2 will be equal to L. Unless requested otherwise, bend attenuators would be supplied with L1 equal to L2.

### Alternative Construction

**SABHP**
Type SABHP; as for type SABH but with the casing thickness increased to Ga.18 to comply with ductwork codes SMACNA stds. high pressure & DW 144 Class C or D.

**SABHM**
Type SABHM; as for type SABH but the acoustic infill is enveloped in a Melinex polyester film.

**SABHF**
Type SABHF; as for type SABH but with rolled steel angle end flanges drilled to a standard pattern.

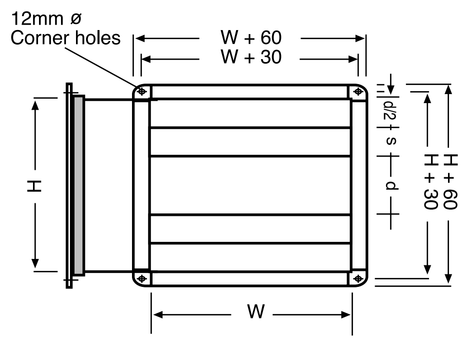
### Sectionalised Construction

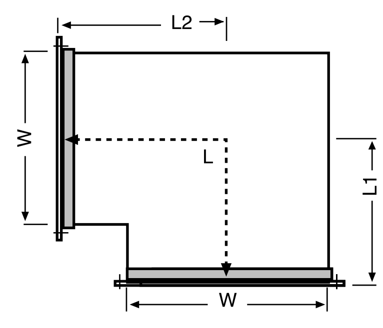
SABH attenuators are normally supplied in sections when any of the following dimensions are exceeded: W=2100mm, H=1800mm, L=2100mm

The assembly of sectionalised attenuators is on site, by others. SAFID will provide full details of attenuator configuration and assembly.

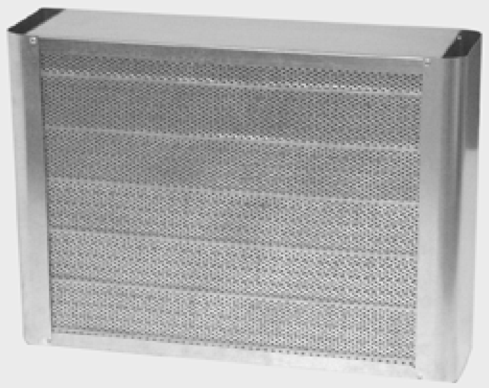
### Dimensions

Horizontal Mounting Bend Attenuator: Type SABH



SAS



## Description

The splitter or baffle are usually filled with acoustic infill, made to fit into builders work, ducts and shafts. It is designed for reducing fan noise, meeting specified Noise levels such as NC or NR.

## Construction

**Type SAS**
Where preferred, Type SAS splitters only can be supplied for inclusion in an AHU section or builders work duct. Where required, airway spacer channels can be supplied.

The splitters contain acoustic infill which complies with Class O Building Regulations. The infill has a glass tissue facing and is contained behind perforated metal; this dual protection prevents damage and fibre erosion up to 30 m/s airway velocity. The splitters are radiussed at both ends to minimize air pressure loss and regenarated noise.

A combination of acoustic splitter and airway produces an attenuator 'module'. The first 'module' comprises two half width side liners plus an airway.

## Alternative Construction

**SASM**
Type SASM; as for type SAS but the acoustic infill is enveloped in a melinex polyester film.

## Dimensions

Splitter Type SAS

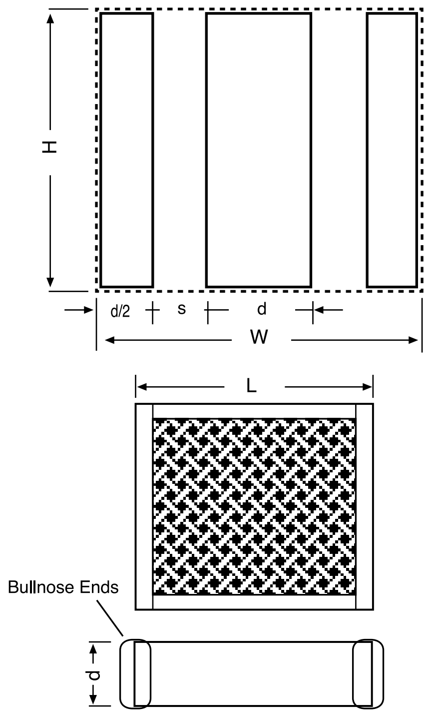











**Table 1: Recommended design Criteria for Various Area Functions**

| Situation | NC |
|---|---|
| **Section 1 - Studios and Auditoria** | |
| Sound Broadcasting (drama) | 15 |
| Sound Broadcasting (general), TV (general), Recording Studio | 20 |
| TV (audience studio) | 25 |
| Concert Hall, Theatre | 20 - 25 |
| Lecture Theatre, Cinema | 25 - 30 |
| **Section 2 - Hospitals** | |
| Audiometric Room | 20 - 25 |
| Operating Theatre, Single Bed Ward | 30 - 35 |
| Multi-bed Ward, Waiting room | 35 |
| Corridor, Laboratory | 35 - 40 |
| Wash Room, Toilet, Kitchen | 35 - 45 |
| Staff Room, Recreation Room | 30 - 40 |
| **Section 3 - Hotels** | |
| Individual Room, Suite | 20 - 30 |
| Ballroom, Banquet Room | 30 - 35 |
| Corridor, Lobby | 35 - 40 |
| Kitchen, Laundry | 40 -45 |
| **Section 4 - Restaurants, Shops and Stores** | |
| Restaurant, Department Store (upper floor) | 35 - 40 |
| Club, Public House, Cafeteria, Canteen, Retail Store (main floor) | 40 - 45 |
| **Section 5 - Offices** | |
| Boardroom, Large Conference Room | 25 - 30 |
| Small Conference Room, Executive Office, Reception Room | 30 - 35 |
| Open Plan Office | 35 |
| Drawing Office, Computer Suite | 35 - 45 |
| **Section 6 - Public Buildings** | |
| Court Room | 25 - 30 |
| Assembly Hall | 25 - 35 |
| Library, Bank, Museum | 30 - 35 |
| Wash Room, Toilet | 35 - 45 |
| Swimming Pool, Sports Arena | 40 - 45 |
| Garage, Car Park | 55 |
| **Section 7 - Ecclesiastical and Academic Buildings** | |
| Church, Mosque | 25 - 30 |
| Classroom, Lecture Theatre | 25 - 35 |
| Laboratory, Workshop | 35 - 40 |
| Corridor, Gymnasium | 35 - 45 |
| **Section 8 - Industrial** | |
| Warehouse, Garage | 45 - 50 |
| Workshop (light engineering) | 45 - 55 |
| Workshop (heavy engineering) | 50 - 65 |
| **Section 9 - Private Dwelling (Urban)** | |
| Bedroom | 25 |
| Living Room | 30 |

SA attenuator have been rated, tested and derived from tests meeting the requirements of BS 4718: 1971 as tests conducted by SRL of UK.

No deviations of insertion loss with airflow were recorded over the range of velocities employed in this catalogue. Static insertion loss figures are provided in Table 3.
Full regenerated noise data is available for SA attenuators to enable installed insertion loss to be calculated. Table 2 gives guidelines for maximum face velocity against design noise level requirements, in order to limit attenuator regenerated noise.

Pressure loss data assumes that the airflow to the attenuator is uniform over the face, in a duct-to-duct layout. Units installed in situations leading to poor inlet or discharge conditions could incur pressure losses higher than catalogued.

In most applications the requirement to keep the pressure drop across the attenuator to a reasonable level automatically ensures that the flow noise generated within the attenuator is insignificant compared with the permissible sound power which emerges. If however, extremely low levels have to be obtained, or if the sound power from the fan is relatively low, the flow noise generated by the attenuator can be significant and can reduce its effective insertion loss. It is for this reason that when an acoustic consultant specifies the attenuator performance he will normally specify the insertion loss which is required. This then enables the attenuator manufacturer to select a unit of such a size that the flow generated within it will not reduce the effective insertion loss below the required level.

Assuming correct installation, acoustic and aerodynamic performance of splitters only will be as for a cased attenuator.

## Description

Space noise levels can be affected by attenuator self noise. As a guide it is recommended that the face velocities indicated are not exceeded. For systems with fewer than three outlets or less than 5m of ductwork, size for 5NC lower. For design levels of NC30 or below the selection should be checked by SAFID.

**Table 2: Installed Insertion Loss (Velocity)**

| Required Space Noise Level (NC) | Face Velocity ($v_t$ m/s) | | | |
|---|---|---|---|---|
| | Attenuator Type | | | |
| | SA 20 - 75 | SA 20 - 100 | SA 20 - 150 | SA 20 - 200 |
| **25** | 2.4 | 3.2 | 3.9 | 5.0 |
| **30** | 3.2 | 4.2 | 5.5 | 6.2 |
| **35** | 3.8 | 5.0 | 6.7 | 7.4 |
| **40** | 4.6 | 5.7 | 7.7 | 8.9 |
| **45** | 5.4 | 6.6 | 8.6 | 10.4 |
| **50** | 6.2 | 7.6 | 9.7 | 11.6 |









**Table 3: Static Insertion Loss (dB)**

| SA 20 - 75 Attenuators | | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| SA 20 - 75 | 600 | 9 | 13 | 22 | 36 | 45 | 39 | 33 | 29 |
| SA 20 - 75 | 900 | 10 | 16 | 27 | 41 | 49 | 47 | 38 | 33 |
| SA 20 - 75 | 1200 | 11 | 18 | 31 | 46 | 50 | 50 | 43 | 38 |
| SA 20 - 75 | 1500 | 12 | 21 | 36 | 50 | 50 | 50 | 48 | 42 |
| SA 20 - 75 | 1800 | 13 | 24 | 41 | 50 | 50 | 50 | 50 | 46 |
| SA 20 - 75 | 2100 | 14 | 26 | 45 | 50 | 50 | 50 | 50 | 50 |
| SA 20 - 75 | 2400 | 15 | 29 | 50 | 50 | 50 | 50 | 50 | 50 |

| SA 20 - 100 Attenuators | | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| SA 20 - 100 | 600 | 7 | 10 | 18 | 34 | 46 | 40 | 33 | 29 |
| SA 20 - 100 | 900 | 8 | 12 | 22 | 37 | 50 | 46 | 36 | 31 |
| SA 20 - 100 | 1200 | 9 | 14 | 26 | 40 | 50 | 50 | 39 | 33 |
| SA 20 - 100 | 1500 | 9 | 17 | 30 | 44 | 50 | 50 | 41 | 35 |
| SA 20 - 100 | 1800 | 10 | 19 | 34 | 47 | 50 | 50 | 44 | 37 |
| SA 20 - 100 | 2100 | 11 | 21 | 38 | 50 | 50 | 50 | 47 | 39 |
| SA 20 - 100 | 2400 | 11 | 24 | 42 | 50 | 50 | 50 | 49 | 41 |

| SA 20 - 150 Attenuators | | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| SA 20 - 150 | 600 | 8 | 12 | 17 | 34 | 44 | 28 | 23 | 22 |
| SA 20 - 150 | 900 | 8 | 14 | 20 | 37 | 47 | 32 | 26 | 24 |
| SA 20 - 150 | 1200 | 9 | 15 | 23 | 40 | 50 | 36 | 29 | 26 |
| SA 20 - 150 | 1500 | 10 | 17 | 26 | 43 | 53 | 40 | 32 | 28 |
| SA 20 - 150 | 1800 | 11 | 18 | 29 | 46 | 57 | 44 | 35 | 31 |
| SA 20 - 150 | 2100 | 11 | 20 | 32 | 49 | 40 | 48 | 38 | 33 |
| SA 20 - 150 | 2400 | 12 | 21 | 35 | 50 | 50 | 50 | 41 | 35 |

| SA 20 - 200 Attenuators | | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| SA 20 - 200 | 600 | 7 | 11 | 16 | 25 | 27 | 23 | 21 | 20 |
| SA 20 - 200 | 900 | 8 | 12 | 18 | 30 | 33 | 26 | 23 | 21 |
| SA 20 - 200 | 1200 | 8 | 14 | 21 | 35 | 39 | 30 | 25 | 23 |
| SA 20 - 200 | 1500 | 9 | 15 | 23 | 40 | 44 | 33 | 28 | 24 |
| SA 20 - 200 | 1800 | 9 | 17 | 26 | 45 | 50 | 37 | 30 | 26 |
| SA 20 - 200 | 2100 | 10 | 18 | 28 | 50 | 50 | 40 | 32 | 27 |
| SA 20 - 200 | 2400 | 11 | 19 | 30 | 50 | 50 | 43 | 34 | 28 |

## Quick Selection

The SAFID leaflet titled “Sound and Noise Control” and other technical sources, describe the method for full acoustic analysis. If attenuator performance requirements have been established in this way, then reference should be made to Table 3.

However, to enable engineers to produce attenuator selections to assist in design planning, Table 4 has been devised. It is recommended that SAFID engineers check the attenuators selections, when detailed system data is available.

Requirements for noise levels of NC30 or below should be referred to SAFID for analysis.

Larger and alternative cross section can be selected from Tables 5 to 8. Note that the width dimension (Type SA) or height dimension (Type SAH) must be in a ‘modular’ increment. Air pressure loss can be taken from the tables for the appropriate face velocity.

For Atmosphere side noise assessment consult SAFID.

## Method of Selection

1 From Table 1 select the recommended space NC level for the type of area concerned.

2 From Table 4 select an attenuator for appropriate fan static pressure, type of ventilated space and space NC level.

3 From Table 2 check for maximum attenuator face velocity permissible for space NC level required.

4 From Table 5 to 8 as applicable, select a cross section for the attenuator for the volume frlo rate required and to satisfy the maximum desirable face velocity / pressure loss.

5 Selection example:
SA20-150 / 700W x 600H x 1500L

**Table 4: Attenuator Quick Selection Chart**

| | | Type of ventilated area being served by low velocity systems utilizing DW 142 Classes A or B ductwork | | | | | | | | | High velocity CV/ VAV systems incorporating terminal units and utilizing DW 142 Class C ductwork. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rooms with average furnishing: floors carpeted, including: | | | Rooms with limited furnishings: mainly hard surfaces, including: | | | Rooms without soft furnishings, including: | | | |
| | | Offices, Banks, Libraries, Lecture rooms, Restaurants Hotel rooms, Department stores. | | | Hospital areas, Supermarkets, Computer rooms, Clean rooms, Laboratories, Cafes, Dance Halls, Museums, Canteens, Toilets. | | | Kitchens, Swimming Pools, Sports Halls, Covered garages, Warehouses. | | | |
| Fan Static Pressure | | 250 Pa | 500 Pa | 1000 Pa | 250 Pa | 500 Pa | 1000 Pa | 250 Pa | 500 Pa | 1000 Pa | 2000 Pa Max |
| Criterion | Type | Attenuator Length (mm) | | | Attenuator Length (mm) | | | Attenuator Length (mm) | | | Attenuator Length (mm) |
| NC 45 | SA20-100 | 900 | 900 | 900 | 900 | 900 | 1200 | 900 | 900 | 1500 | 1200 |
| | SA20-150 | 900 | 1200 | 1200 | 1200 | 1500 | 1800 | 1500 | 900 | 2100 | 1800 |
| NC 40 | SA20-100 | 900 | 900 | 1200 | 1200 | 1200 | 1500 | 1200 | 1500 | 1500 | 1500 |
| | SA20-150 | 1200 | 1500 | 1800 | 1500 | 1800 | 2100 | 1800 | 2100 | 2100 | 2100 |
| NC 35 | SA20-100 | 1200 | 1200 | 1500 | 1500 | 1500 | 1800 | 1500 | 1800 | 1800 | 1800 |
| | SA20-150 | 1500 | 1800 | 2100 | 1800 | 2100 | 1400 | 1800 | 2100 | 2400 | 2400 |

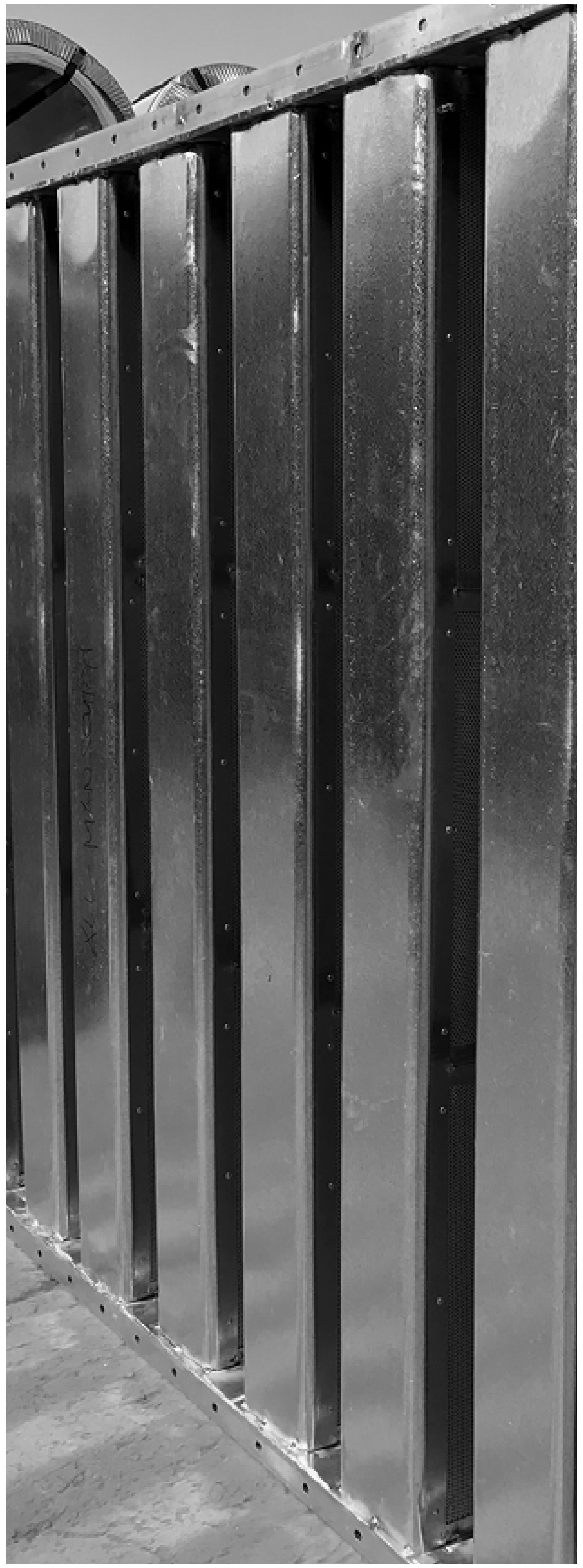








## FULL METHOD



## Full Selection

When an attenuator performance requirement has been established, for example, after following the procedure in the Safid “Sound & Noise Control” brochure, a suitable SA attenuator can be selected from the following Method of Selection. If the acoustic performance is not known, then a selection can be obtained using the Quick Slection Method on page 46.

Larger and alternative cross sections can be selected from Tables 5 to 8. Note that the width dimension (Type SA) or height dimension (Type SAH) must be in a ‘modular’ increment. Air pressure loss can be taken from the tables for the appropriate face velocity.

## Method of Selection

1 From Table 3 select an attenuator to meet the performance needs.

2 From Table 2 check for maximum attenuator face velocity permissible for space NC level required.

3 From Table 5 to 8 as applicable, select an attenuator cross-section for the required volume flow rate and to satisfy the maximum desirable face velocity / pressure loss.

4 Selection example:
SA20-100 / 600W x 600H x 1200L

**NOTE**

The data below should not be used where Melinex (polyester membrane) faced attenuators are rquired, since the use of the membrane modifies acoustic performance.
Performance requirements higher than shown in Table 3 should be referred to SAFID for selection.

## ATTENUATOR PERFORMANCE I TYPE SA 20 - 75

Table 5: Pressure Loss - Cross Section Sizing

| Pressure Loss (Δp, Pa) | | 15 | 25 | 35 | 50 | 60 | 75 | 85 | 100 | 110 | 125 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Face Velocity ($v_t$ m/s) | | 1.6 | 2.1 | 2.4 | 2.9 | 3.2 | 3.5 | 3.8 | 4.0 | 4.3 | 4.6 |
| Attenuator Self Noise guide Against Face Velocity ($v_t$) | | | | NC 25 | | NC 30 | | NC 35 | | | NC 40 |
| Width (mm) | Height (mm) | Volume Flow Rate (V l/s) | | | | | | | | | |
| 275 | 150 | 65 | 85 | 100 | 120 | 130 | 145 | 155 | 165 | 175 | 190 |
| | 300 | 130 | 170 | 200 | 240 | 260 | 290 | 310 | 330 | 350 | 380 |
| ONE | 450 | 200 | 260 | 300 | 360 | 400 | 430 | 470 | 500 | 530 | 570 |
| MODULE | 600 | 260 | 350 | 400 | 480 | 530 | 580 | 630 | 660 | 710 | 760 |
| | 750 | 330 | 430 | 500 | 600 | 660 | 720 | 780 | 830 | 890 | 950 |
| | 900 | 400 | 520 | 590 | 720 | 790 | 870 | 940 | 990 | 1060 | 1140 |
| 550 | 300 | 260 | 350 | 400 | 480 | 530 | 580 | 630 | 660 | 710 | 760 |
| | 450 | 400 | 520 | 590 | 720 | 790 | 870 | 940 | 990 | 1060 | 1140 |
| TWO | 600 | 530 | 690 | 790 | 960 | 1060 | 1160 | 1250 | 1320 | 1420 | 1520 |
| MODULES | 750 | 660 | 870 | 990 | 1200 | 1320 | 1440 | 1570 | 1650 | 1770 | 1900 |
| | 900 | 790 | 1040 | 1190 | 1440 | 1580 | 1730 | 1880 | 1980 | 2130 | 2280 |
| | 1050 | 920 | 1210 | 1390 | 1670 | 1850 | 2020 | 2190 | 2310 | 2480 | 2660 |
| 825 | 450 | 590 | 780 | 890 | 1080 | 1190 | 1300 | 1410 | 1490 | 1600 | 1710 |
| | 600 | 790 | 1040 | 1190 | 1440 | 1580 | 1730 | 1880 | 1980 | 2130 | 2280 |
| THREE | 750 | 990 | 1300 | 1490 | 1790 | 1980 | 2170 | 2350 | 2480 | 2660 | 2850 |
| MODULES | 900 | 1190 | 1560 | 1780 | 2150 | 2380 | 2600 | 2820 | 2970 | 3190 | 3420 |
| | 1050 | 1390 | 1820 | 2080 | 2510 | 2770 | 3030 | 3290 | 3470 | 3720 | 3980 |
| | 1200 | 1580 | 2080 | 2380 | 2870 | 3170 | 3470 | 3760 | 3960 | 4260 | 4550 |
| 1100 | 600 | 1060 | 1390 | 1580 | 1910 | 2110 | 2310 | 2510 | 2640 | 2840 | 3040 |
| | 750 | 1320 | 1730 | 1980 | 2390 | 2640 | 2890 | 3140 | 3300 | 3550 | 3800 |
| FOUR | 900 | 1580 | 2080 | 2380 | 2870 | 3170 | 3470 | 3760 | 3960 | 4260 | 4550 |
| MODULES | 1050 | 1850 | 2430 | 2770 | 3350 | 3700 | 4040 | 4390 | 4620 | 4970 | 5310 |
| | 1200 | 2110 | 2770 | 3170 | 3830 | 4220 | 4620 | 5020 | 5280 | 5680 | 6070 |
| | 1350 | 2380 | 3120 | 3560 | 4310 | 4750 | 5200 | 5640 | 5940 | 6390 | 6830 |
| 1375 | 750 | 1650 | 2170 | 2480 | 2990 | 3300 | 3610 | 3920 | 4130 | 4430 | 4740 |
| | 900 | 1980 | 2600 | 2970 | 3590 | 3960 | 4330 | 4700 | 4950 | 5320 | 5690 |
| FIVE | 1050 | 2310 | 3030 | 3460 | 4190 | 4620 | 5050 | 5490 | 5780 | 6210 | 6640 |
| MODULES | 1200 | 2640 | 3470 | 3960 | 4790 | 5280 | 5780 | 6270 | 6600 | 7100 | 7590 |
| | 1350 | 2970 | 3900 | 4460 | 5380 | 5940 | 6500 | 7050 | 7430 | 7980 | 8540 |
| | 1500 | 3300 | 4330 | 4950 | 5980 | 6600 | 7220 | 7840 | 8250 | 8870 | 9490 |
| 1650 | 900 | 2380 | 3120 | 3560 | 4310 | 4750 | 5200 | 5640 | 5940 | 6390 | 6830 |
| | 1050 | 2770 | 3640 | 4160 | 5020 | 5540 | 6060 | 6590 | 6930 | 7450 | 7970 |
| SIX | 1200 | 3170 | 4160 | 4750 | 5740 | 6340 | 6930 | 7520 | 7920 | 8510 | 9110 |
| MODULES | 1350 | 3560 | 4680 | 5350 | 6460 | 7130 | 7800 | 8460 | 8910 | 9580 | 10250 |
| | 1500 | 3960 | 5200 | 5940 | 7180 | 7920 | 8660 | 9400 | 9900 | 10640 | 11390 |
| | 1650 | 4360 | 5720 | 6530 | 7900 | 8710 | 9530 | 10350 | 10890 | 11710 | 12520 |
| | 1800 | 4750 | 6240 | 7130 | 8610 | 9500 | 10400 | 11290 | 11880 | 12770 | 13660 |
| 1925 | 1050 | 3230 | 4240 | 4850 | 5860 | 6470 | 7070 | 760 | 8090 | 8690 | 9300 |
| | 1200 | 3700 | 4850 | 5540 | 6700 | 7390 | 8090 | 8780 | 9240 | 9930 | 10630 |
| SEVEN | 1350 | 4160 | 5460 | 6240 | 7540 | 8320 | 9100 | 9880 | 10400 | 11170 | 11950 |
| MODULES | 1500 | 4620 | 6060 | 6930 | 8370 | 9240 | 10110 | 10970 | 11550 | 12420 | 13280 |
| | 1650 | 5080 | 6670 | 7620 | 9210 | 10160 | 11120 | 12070 | 12700 | 13660 | 14610 |
| | 1800 | 5540 | 7280 | 8320 | 10050 | 11090 | 12130 | 13170 | 13860 | 14900 | 15940 |
| | 1950 | 6010 | 7880 | 9010 | 10890 | 12010 | 13140 | 14260 | 15020 | 16140 | 17270 |
| | 2100 | 6470 | 8490 | 9700 | 11720 | 12940 | 14150 | 15360 | 16170 | 17380 | 18600 |
| 2200 | 1200 | 4220 | 5540 | 6340 | 7660 | 8450 | 9240 | 10030 | 10560 | 11350 | 12140 |
| | 1350 | 4750 | 6240 | 7130 | 8610 | 9500 | 10400 | 11290 | 11880 | 12770 | 13660 |
| EIGHT | 1500 | 5280 | 6930 | 7920 | 9570 | 10560 | 11550 | 12540 | 13200 | 14190 | 15180 |
| MODULES | 1650 | 5810 | 7620 | 8710 | 10530 | 11620 | 12710 | 13790 | 14520 | 15610 | 16700 |
| | 1800 | 6340 | 8320 | 950 | 11480 | 12670 | 13860 | 15050 | 15840 | 17030 | 18220 |
| | 1950 | 6860 | 9010 | 10300 | 12440 | 13730 | 15020 | 16300 | 17160 | 18450 | 19730 |
| | 2100 | 7390 | 9700 | 11090 | 13500 | 14780 | 16170 | 17560 | 18480 | 19870 | 21250 |
| | 2250 | 7920 | 10400 | 11880 | 14360 | 15840 | 17330 | 18810 | 19800 | 21290 | 22770 |
| 2475 | 1350 | 5350 | 7020 | 8020 | 9690 | 10690 | 11960 | 12700 | 13370 | 14370 | 15370 |
| | 1500 | 5940 | 7800 | 8910 | 10770 | 11880 | 12990 | 14110 | 14850 | 15960 | 17080 |
| NINE | 1650 | 6530 | 8580 | 9800 | 11840 | 13070 | 14290 | 15520 | 16330 | 17560 | 18790 |
| MODULES | 1800 | 7130 | 9360 | 10690 | 12920 | 14260 | 15590 | 16930 | 17820 | 19160 | 20490 |
| | 1950 | 7720 | 10140 | 11580 | 14000 | 15440 | 16890 | 18340 | 19300 | 20750 | 22200 |
| | 2100 | 8320 | 10910 | 12470 | 15070 | 16630 | 18190 | 19750 | 20790 | 22350 | 23910 |
| | 2250 | 8910 | 11690 | 13370 | 16150 | 17820 | 19490 | 21160 | 22280 | 23950 | 25620 |
| | 2400 | 9500 | 12470 | 14260 | 17230 | 19010 | 20790 | 22570 | 23760 | 25540 | 27320 |

The pressure loss data above relates to a straight attenuator 1200mm long. The following factors are applicable to other lengths:

| Length 'L' (mm) | 600 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 |
|---|---|---|---|---|---|---|---|
| Δp Factor | x 0.90 | x0.95 | 0 | x1.05 | x1.10 | x1.15 | x1.20 |

For splitter bend attenuators add 35% to the pressure loss for the straight attenuator.









## ATTENUATOR PERFORMANCE I TYPE SA 20 - 100

Table 6: Pressure Loss - Cross Section Sizing

| Pressure Loss (Δp, Pa) | | 15 | 25 | 35 | 50 | 60 | 75 | 85 | 100 | 110 | 125 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Face Velocity ($v_t$ m/s) | | 2.1 | 2.7 | 3.2 | 3.8 | 4.2 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 |
| Attenuator Self Noise guide Against Face Velocity ($v_t$) | | | | NC 25 | | NC 30 | | NC 35 | | | NC 40 |
| Width (mm) | Height (mm) | Volume Flow Rate (V l/s) | | | | | | | | | |
| 300 | 150 | 95 | 120 | 145 | 170 | 190 | 210 | 225 | 245 | 255 | 270 |
| | 300 | 190 | 240 | 290 | 340 | 380 | 420 | 450 | 490 | 510 | 540 |
| ONE | 450 | 280 | 360 | 430 | 510 | 570 | 630 | 680 | 730 | 770 | 810 |
| MODULE | 600 | 380 | 490 | 580 | 680 | 760 | 850 | 900 | 970 | 1030 | 1080 |
| | 750 | 470 | 610 | 720 | 860 | 950 | 1060 | 1130 | 1220 | 1280 | 1350 |
| | 900 | 570 | 730 | 860 | 1030 | 1130 | 1270 | 1350 | 1460 | 1540 | 1620 |
| 600 | 300 | 380 | 490 | 580 | 680 | 760 | 850 | 900 | 970 | 1030 | 1080 |
| | 450 | 570 | 730 | 860 | 1030 | 1130 | 1270 | 1350 | 1460 | 1540 | 1620 |
| TWO | 600 | 760 | 970 | 1150 | 1370 | 1510 | 1690 | 1800 | 1940 | 2050 | 2160 |
| MODULES | 750 | 950 | 1200 | 1440 | 1710 | 1890 | 2120 | 2250 | 2430 | 2570 | 2700 |
| | 900 | 1130 | 1460 | 1730 | 2050 | 2270 | 2540 | 2700 | 2920 | 3080 | 3240 |
| | 1050 | 1320 | 1700 | 2020 | 2390 | 2650 | 2960 | 3150 | 3400 | 3590 | 3780 |
| 900 | 1200 | 1510 | 1940 | 2300 | 2740 | 3020 | 3380 | 3600 | 3830 | 4100 | 4320 |
| | 450 | 850 | 1090 | 1300 | 1540 | 1700 | 1900 | 2030 | 2190 | 2310 | 2430 |
| THREE | 600 | 1130 | 1460 | 1730 | 2050 | 2270 | 2540 | 2700 | 2920 | 3080 | 3240 |
| MODULES | 750 | 1420 | 1820 | 2160 | 2570 | 2840 | 3170 | 3380 | 3650 | 3850 | 4050 |
| | 900 | 1700 | 2190 | 2590 | 3080 | 3400 | 3810 | 4050 | 4370 | 4620 | 4860 |
| | 1050 | 1990 | 2550 | 3020 | 3590 | 3970 | 4440 | 4730 | 5100 | 5390 | 5670 |
| 1200 | 1200 | 2270 | 2920 | 3460 | 4100 | 4540 | 5080 | 5400 | 5830 | 6160 | 6480 |
| | 1350 | 2550 | 3280 | 3890 | 4620 | 5100 | 5710 | 6080 | 6560 | 6930 | 7290 |
| FOUR | 600 | 1510 | 1940 | 2300 | 2740 | 3020 | 3380 | 3600 | 3830 | 4100 | 4320 |
| MODULES | 750 | 1890 | 2430 | 2880 | 3420 | 3780 | 4230 | 4500 | 4860 | 5130 | 5400 |
| | 900 | 2270 | 2920 | 3460 | 4100 | 4540 | 5080 | 5400 | 5830 | 6160 | 6480 |
| | 1050 | 2650 | 3400 | 4030 | 4790 | 5290 | 5920 | 6300 | 6800 | 7180 | 7560 |
| 1500 | 1200 | 3020 | 3890 | 4610 | 5470 | 6050 | 6790 | 7200 | 7780 | 8210 | 8640 |
| | 1350 | 3400 | 4370 | 5180 | 6160 | 6800 | 7610 | 8100 | 8750 | 9230 | 9720 |
| | 1500 | 3780 | 4860 | 5760 | 6840 | 7560 | 8560 | 900 | 9720 | 10260 | 10800 |
| | 750 | 2360 | 3040 | 3600 | 4280 | 4730 | 5290 | 5630 | 6080 | 6410 | 6750 |
| | 900 | 2840 | 3650 | 4320 | 5130 | 5670 | 6350 | 6750 | 7290 | 7700 | 8100 |
| FIVE | 1050 | 3310 | 4250 | 5040 | 5990 | 6620 | 7400 | 7880 | 8510 | 8980 | 9450 |
| MODULES | 1200 | 3780 | 4860 | 5760 | 6840 | 7560 | 8460 | 9000 | 9720 | 10260 | 10800 |
| | 1350 | 4250 | 5470 | 6480 | 7700 | 8510 | 9520 | 10130 | 10940 | 11540 | 12150 |
| | 1500 | 4730 | 6080 | 7200 | 8550 | 9450 | 10580 | 11250 | 12150 | 12830 | 13500 |
| | 1650 | 5200 | 6680 | 7920 | 9410 | 10400 | 11630 | 12380 | 13370 | 14110 | 14850 |
| | 1800 | 5670 | 7290 | 8640 | 10260 | 11340 | 12690 | 13500 | 14580 | 15390 | 16200 |
| 1800 | 900 | 3400 | 4370 | 5180 | 6160 | 6800 | 7610 | 8100 | 8750 | 9230 | 9720 |
| | 1050 | 3970 | 5100 | 6050 | 7180 | 7940 | 8880 | 9450 | 10210 | 10770 | 11340 |
| SIX | 1200 | 4540 | 5830 | 6910 | 8210 | 9070 | 10150 | 10800 | 11660 | 12310 | 12960 |
| MODULES | 1350 | 5100 | 6560 | 7780 | 9230 | 10210 | 11420 | 12150 | 13120 | 13850 | 14580 |
| | 1500 | 5670 | 7290 | 8640 | 10260 | 11340 | 12690 | 13500 | 14580 | 15390 | 16200 |
| | 1650 | 6240 | 8020 | 9500 | 11290 | 12470 | 13960 | 14850 | 16040 | 16930 | 17820 |
| | 1800 | 6800 | 8750 | 10370 | 12310 | 13610 | 15230 | 16200 | 17500 | 18740 | 19440 |
| | 1950 | 7370 | 9480 | 11230 | 13340 | 14740 | 16500 | 17550 | 18950 | 20010 | 21060 |
| 2100 | 1050 | 4630 | 5950 | 7060 | 8380 | 9260 | 10360 | 11030 | 11910 | 12570 | 13230 |
| | 1200 | 5290 | 6800 | 8060 | 9580 | 10580 | 11840 | 12600 | 13610 | 14360 | 15120 |
| SEVEN | 1350 | 5950 | 7650 | 9070 | 10770 | 11910 | 12320 | 14180 | 15310 | 16160 | 17010 |
| MODULES | 1500 | 6620 | 8510 | 10080 | 11970 | 13230 | 14810 | 15750 | 17010 | 17960 | 18900 |
| | 1650 | 7280 | 9360 | 11090 | 13170 | 14550 | 16290 | 17330 | 18710 | 19750 | 20790 |
| | 1800 | 7940 | 10210 | 12100 | 14360 | 15880 | 17770 | 18900 | 20410 | 21550 | 22680 |
| | 1950 | 8600 | 11060 | 13100 | 15560 | 17200 | 19250 | 20480 | 22110 | 23340 | 24570 |
| | 2100 | 9260 | 11910 | 14110 | 16760 | 18520 | 20730 | 22050 | 23810 | 25140 | 26460 |
| | 2250 | 9920 | 12760 | 15120 | 17960 | 19850 | 22210 | 23630 | 25520 | 26930 | 28350 |
| 2400 | 1200 | 6050 | 7780 | 9220 | 10940 | 12100 | 13540 | 1440 | 15550 | 16440 | 17280 |
| | 1350 | 6800 | 8750 | 10370 | 12310 | 13610 | 15230 | 16200 | 17500 | 18470 | 19440 |
| EIGHT | 1500 | 7560 | 9720 | 11520 | 13680 | 15120 | 16920 | 18000 | 19440 | 20520 | 21600 |
| MODULES | 1650 | 8320 | 10690 | 12670 | 15050 | 16630 | 18610 | 19800 | 21380 | 22570 | 23760 |
| | 1800 | 9070 | 11670 | 13820 | 16420 | 18140 | 20300 | 21600 | 23330 | 24620 | 25920 |
| | 1950 | 9830 | 12640 | 14980 | 17780 | 19660 | 22000 | 23400 | 25270 | 26680 | 28080 |
| | 2100 | 10580 | 13610 | 16130 | 19150 | 21170 | 23690 | 25200 | 27220 | 28730 | 30240 |
| | 2250 | 11340 | 14580 | 17280 | 20520 | 22680 | 25380 | 27000 | 29160 | 30780 | 32400 |
| | 2400 | 12100 | 15560 | 18430 | 21890 | 24190 | 27070 | 28800 | 31100 | 32830 | 34560 |

The pressure loss data above relates to a straight attenuator 1200mm long. The following factors are applicable to other lengths:

| Length 'L' (mm) | 600 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 |
|---|---|---|---|---|---|---|---|
| Δp Factor | x 0.90 | x0.95 | 0 | x1.05 | x1.10 | x1.15 | x1.20 |

For splitter bend attenuators add 40% to the pressure loss for the straight attenuator.

## ATTENUATOR PERFORMANCE I TYPE SA 20 - 150

Table 7: Pressure Loss - Cross Section Sizing

| Pressure Loss (Δ p, Pa) | | 15 | 25 | 35 | 50 | 60 | 75 | 85 | 100 | 110 | 125 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Face Velocity ($v_t$ m/s) | | 3.0 | 3.9 | 4.6 | 5.5 | 6.0 | 6.7 | 7.1 | 7.7 | 8.1 | 8.6 |
| Attenuator Self Noise guide Against Face Velocity ($v_t$) | | | NC 25 | | NC 30 | | NC 35 | | NC 40 | | NC45 |
| Width (mm) | Height (mm) | Volume Flow Rate (V l/s) | | | | | | | | | |
| 350 | 150 | 160 | 205 | 240 | 290 | 315 | 350 | 375 | 405 | 425 | 450 |
| | 300 | 320 | 410 | 480 | 580 | 630 | 700 | 750 | 810 | 850 | 900 |
| ONE | 450 | 470 | 610 | 720 | 870 | 950 | 1060 | 1120 | 1210 | 1280 | 1350 |
| MODULE | 600 | 630 | 820 | 970 | 1160 | 1260 | 1410 | 1490 | 1620 | 1700 | 1810 |
| | 750 | 790 | 1020 | 1210 | 1440 | 1580 | 1760 | 1860 | 2020 | 2130 | 2260 |
| | 900 | 950 | 1230 | 1450 | 1730 | 1890 | 2110 | 2240 | 2430 | 2550 | 2710 |
| 700 | 450 | 950 | 1230 | 1450 | 1730 | 1890 | 2110 | 2240 | 2430 | 2550 | 2710 |
| | 600 | 1260 | 1640 | 1930 | 2310 | 2520 | 2810 | 2980 | 3230 | 3400 | 3610 |
| TWO | 750 | 1580 | 2050 | 2420 | 2890 | 3150 | 3520 | 3720 | 4040 | 4250 | 4520 |
| MODULES | 900 | 1890 | 2460 | 2900 | 3470 | 3780 | 4220 | 4470 | 4850 | 5100 | 5420 |
| | 1050 | 2210 | 2870 | 3380 | 4040 | 4410 | 4920 | 5220 | 5660 | 5950 | 6320 |
| | 1200 | 2520 | 3280 | 3860 | 4620 | 5040 | 5630 | 5960 | 6470 | 6800 | 7220 |
| 1050 | 600 | 1890 | 2460 | 2900 | 3470 | 3780 | 4220 | 4470 | 4850 | 5100 | 5420 |
| | 750 | 2360 | 3070 | 3620 | 4330 | 4730 | 5280 | 5590 | 6060 | 6380 | 6770 |
| THREE | 900 | 2840 | 3690 | 4350 | 5200 | 5670 | 6330 | 6710 | 7280 | 7650 | 8130 |
| MODULES | 1050 | 3310 | 4300 | 5070 | 6060 | 6620 | 7390 | 7830 | 8490 | 8930 | 9480 |
| | 1200 | 3780 | 4910 | 5800 | 6930 | 7560 | 8440 | 8950 | 9700 | 10210 | 10840 |
| | 1350 | 4250 | 5530 | 6520 | 7800 | 8510 | 9500 | 10060 | 10910 | 11480 | 12190 |
| | 1500 | 4730 | 6140 | 7240 | 8660 | 9450 | 10550 | 11180 | 12130 | 12760 | 13550 |
| 1400 | 750 | 3150 | 4090 | 4830 | 5780 | 6300 | 7040 | 7460 | 8090 | 8510 | 9030 |
| | 900 | 3780 | 4910 | 5800 | 6930 | 7560 | 8440 | 8950 | 9700 | 10210 | 10840 |
| FOUR | 1050 | 4410 | 5730 | 6760 | 8090 | 8820 | 9850 | 10440 | 11320 | 11110 | 12640 |
| MODULES | 1200 | 5040 | 6550 | 7730 | 9240 | 10080 | 11260 | 11930 | 12940 | 13610 | 14450 |
| | 1350 | 5670 | 7370 | 8690 | 10400 | 11340 | 12660 | 13420 | 14550 | 15310 | 16250 |
| | 1500 | 6300 | 8190 | 9660 | 11550 | 12600 | 14070 | 14910 | 16170 | 17010 | 18060 |
| | 1650 | 6930 | 9010 | 10630 | 12710 | 13860 | 15480 | 16400 | 17790 | 18710 | 19870 |
| | 1800 | 7560 | 9830 | 11590 | 13860 | 15120 | 16880 | 17890 | 19400 | 20410 | 21670 |
| 1750 | 900 | 4730 | 6140 | 7250 | 8660 | 9450 | 10550 | 11180 | 12130 | 12760 | 13550 |
| | 1050 | 5510 | 7170 | 8450 | 10110 | 11030 | 12310 | 13050 | 14150 | 14880 | 15800 |
| FIVE | 1200 | 6300 | 8190 | 9660 | 11550 | 12600 | 14070 | 14910 | 16170 | 17010 | 18060 |
| MODULES | 1350 | 7090 | 9290 | 10870 | 12990 | 14180 | 15830 | 16770 | 18190 | 19140 | 20320 |
| | 1500 | 7880 | 10240 | 12080 | 14440 | 15750 | 17590 | 18640 | 20210 | 21260 | 22580 |
| | 1650 | 8660 | 11260 | 13280 | 15880 | 17330 | 19350 | 20500 | 22230 | 23390 | 24830 |
| | 1800 | 9450 | 12290 | 14490 | 17330 | 18900 | 21110 | 22370 | 24260 | 25520 | 27090 |
| | 1950 | 10240 | 13310 | 15700 | 18770 | 20480 | 22860 | 24230 | 26280 | 27640 | 29350 |
| | 2100 | 11030 | 14330 | 16910 | 20210 | 22050 | 24620 | 26090 | 28300 | 29770 | 31610 |
| 2100 | 1050 | 6620 | 8600 | 10140 | 12130 | 13230 | 14770 | 15660 | 16980 | 17860 | 18960 |
| | 1200 | 7560 | 9830 | 11590 | 13860 | 15120 | 16880 | 17890 | 19400 | 20410 | 21670 |
| SIX | 1350 | 8510 | 11060 | 13040 | 15590 | 17010 | 19000 | 20130 | 21830 | 22960 | 24380 |
| MODULES | 1500 | 9450 | 12290 | 14490 | 17330 | 18900 | 21110 | 22370 | 24260 | 25520 | 27090 |
| | 1650 | 10400 | 13510 | 15940 | 19060 | 20790 | 23220 | 24600 | 26680 | 28070 | 29800 |
| | 1800 | 11340 | 14740 | 17390 | 20790 | 22680 | 25330 | 26840 | 29110 | 30620 | 32510 |
| | 1950 | 12290 | 15970 | 18840 | 22520 | 24510 | 27440 | 29070 | 31530 | 33170 | 35200 |
| | 2100 | 13230 | 17200 | 20290 | 24260 | 26460 | 29550 | 31310 | 33960 | 35700 | 37900 |
| | 2250 | 14180 | 18430 | 21740 | 25990 | 28350 | 31660 | 33550 | 36380 | 38270 | 40640 |
| 2450 | 1200 | 8820 | 11470 | 13520 | 16170 | 17640 | 19700 | 20870 | 22640 | 23810 | 25280 |
| | 1350 | 9920 | 12800 | 15210 | 18190 | 19850 | 22160 | 23480 | 25470 | 26790 | 28440 |
| SEVEN | 1500 | 11030 | 14330 | 16910 | 20210 | 22050 | 24620 | 26090 | 28300 | 29770 | 31610 |
| MODULES | 1650 | 12130 | 15770 | 18600 | 22230 | 24260 | 27080 | 28700 | 31130 | 32740 | 34770 |
| | 1800 | 13230 | 17200 | 20290 | 24260 | 26460 | 29550 | 31310 | 33960 | 35700 | 37900 |
| | 1950 | 14330 | 18630 | 21980 | 26280 | 28670 | 32000 | 33940 | 36800 | 38700 | 41100 |
| | 2100 | 15440 | 20070 | 23670 | 28300 | 30870 | 34470 | 36500 | 39600 | 41700 | 44300 |
| | 2250 | 16540 | 21500 | 25360 | 30320 | 33080 | 36900 | 39100 | 42500 | 44600 | 47400 |
| | 2400 | 17640 | 22930 | 27050 | 32340 | 35300 | 39400 | 41700 | 45300 | 47600 | 50500 |

The pressure loss data above relates to a straight attenuator 1200mm long. The following factors are applicable to other lengths:

| Length 'L' (mm) | 600 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 |
|---|---|---|---|---|---|---|---|
| Δ p Factor | x 0.90 | x0.95 | 0 | x1.05 | x1.10 | x1.15 | x1.20 |

For splitter bend attenuators add 50% to the pressure loss for the straight attenuator.

SILENCERS







## ATTENUATOR PEROFRMANCE - TYPE SA 20 - 200

Table 8: Pressure Loss - Cross Section Sizing

| Pressure Loss (Δ p, Pa) | | 15 | 25 | 35 | 50 | 60 | 75 | 85 | 100 | 110 | 125 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Face Velocity ($v_t$ m/s) | | 4.0 | 5.0 | 6.2 | 7.4 | 8.0 | 8.9 | 9.6 | 10.4 | 11.0 | 11.6 |
| Attenuator Self Noise guide Against Face Velocity ($v_t$) | | | NC 25 | NC 30 | NC 35 | | NC 40 | | NC45 | | NC50 |
| Width (mm) | Height (mm) | Volume Flow Rate (V l/s) | | | | | | | | | |
| 400 | 150 | 240 | 300 | 370 | 445 | 480 | 535 | 575 | 625 | 660 | 695 |
| | 300 | 480 | 600 | 740 | 890 | 960 | 1070 | 1150 | 1250 | 1320 | 1390 |
| ONE | 450 | 720 | 900 | 1120 | 1330 | 1440 | 1600 | 1730 | 1870 | 1980 | 2090 |
| MODULE | 600 | 960 | 1200 | 1490 | 1780 | 1920 | 2140 | 2300 | 2500 | 2640 | 2780 |
| | 750 | 1200 | 1500 | 1860 | 2220 | 2400 | 2670 | 2880 | 3120 | 3300 | 3480 |
| | 900 | 1440 | 1800 | 2230 | 2660 | 2880 | 3200 | 3460 | 3740 | 3960 | 4180 |
| | 1050 | 1680 | 2100 | 2600 | 3110 | 3360 | 3740 | 4030 | 4370 | 4620 | 4870 |
| | 1200 | 1920 | 2400 | 2980 | 3550 | 3840 | 4270 | 4610 | 4990 | 5280 | 5570 |
| 800 | 450 | 1440 | 1800 | 2230 | 2660 | 2880 | 3200 | 3460 | 3740 | 3960 | 4180 |
| | 600 | 1920 | 2400 | 2980 | 3550 | 3840 | 4270 | 4610 | 4990 | 5280 | 5570 |
| TWO | 750 | 2400 | 3000 | 3720 | 4440 | 4800 | 5340 | 5760 | 6240 | 6600 | 6960 |
| MODULES | 900 | 2880 | 3600 | 4460 | 5330 | 5760 | 6410 | 6910 | 7490 | 7920 | 8350 |
| | 1050 | 3660 | 4200 | 5210 | 6220 | 6720 | 7480 | 8060 | 8740 | 9240 | 9740 |
| | 1200 | 3840 | 4800 | 5950 | 7100 | 7680 | 8540 | 9220 | 9980 | 10560 | 11140 |
| | 1350 | 4320 | 5400 | 6700 | 7990 | 8640 | 9610 | 10370 | 11230 | 11880 | 12530 |
| | 1500 | 4800 | 6000 | 7440 | 8880 | 9600 | 10680 | 11520 | 12480 | 13200 | 13920 |
| 1200 | 600 | 2880 | 3600 | 4460 | 5330 | 5760 | 6410 | 6910 | 7490 | 7920 | 8350 |
| | 750 | 3600 | 4500 | 5580 | 6660 | 7200 | 8010 | 8640 | 9360 | 9900 | 10440 |
| THREE | 900 | 4320 | 5400 | 6700 | 7990 | 8640 | 9610 | 10370 | 11230 | 11880 | 12530 |
| MODULES | 1050 | 5040 | 6300 | 7810 | 9320 | 10080 | 11210 | 12096 | 13100 | 13860 | 14620 |
| | 1200 | 5760 | 7200 | 8930 | 10660 | 11520 | 12820 | 13820 | 14980 | 15840 | 16700 |
| | 1350 | 6480 | 8100 | 10040 | 11990 | 12960 | 14420 | 15550 | 16850 | 17820 | 18790 |
| | 1500 | 7200 | 9000 | 11160 | 13320 | 14400 | 16020 | 17280 | 18720 | 19800 | 20880 |
| | 1650 | 7920 | 9900 | 12280 | 14650 | 15840 | 17620 | 19010 | 20590 | 21780 | 22970 |
| | 1800 | 8640 | 10800 | 13390 | 15980 | 17280 | 19220 | 20740 | 22460 | 23760 | 25060 |
| 1600 | 900 | 5760 | 7200 | 8930 | 10660 | 11520 | 12820 | 13820 | 14980 | 15840 | 16700 |
| | 1050 | 6720 | 8400 | 10420 | 12430 | 13440 | 14950 | 16130 | 17470 | 18480 | 19490 |
| FOUR | 1200 | 7680 | 9600 | 11900 | 14210 | 15360 | 17090 | 18430 | 19970 | 21120 | 22270 |
| MODULES | 1350 | 8640 | 10800 | 13390 | 15980 | 17280 | 19220 | 20740 | 22460 | 23760 | 25060 |
| | 1500 | 9600 | 12000 | 14880 | 17760 | 19200 | 21360 | 23040 | 24960 | 26400 | 27840 |
| | 1650 | 10560 | 13200 | 16370 | 19540 | 21120 | 24500 | 25340 | 27460 | 29040 | 30630 |
| | 1800 | 11520 | 14400 | 17860 | 21310 | 23040 | 25630 | 27650 | 29950 | 31680 | 33410 |
| | 1950 | 12480 | 15600 | 19340 | 23090 | 24960 | 27770 | 29950 | 32450 | 34320 | 36190 |
| | 2100 | 13440 | 16800 | 20830 | 24860 | 26880 | 29900 | 32260 | 34940 | 36960 | 38980 |
| 2000 | 1050 | 8400 | 10500 | 13020 | 15540 | 16800 | 18690 | 20160 | 21840 | 23100 | 24360 |
| | 1200 | 9600 | 12000 | 14880 | 17760 | 19200 | 21360 | 23040 | 24960 | 26400 | 27840 |
| FIVE | 1350 | 10800 | 13500 | 16740 | 19980 | 21600 | 24030 | 25920 | 28080 | 29700 | 31320 |
| MODULES | 1500 | 12000 | 15000 | 18600 | 22200 | 24000 | 26700 | 28800 | 31200 | 33000 | 34800 |
| | 1650 | 13200 | 16500 | 20460 | 24420 | 26400 | 29370 | 31680 | 34320 | 36300 | 38280 |
| | 1800 | 14400 | 18000 | 22320 | 26640 | 28800 | 32040 | 34560 | 37440 | 39600 | 41760 |
| | 1950 | 15600 | 19500 | 24180 | 28860 | 31200 | 34710 | 37440 | 40560 | 42900 | 45240 |
| | 2100 | 16800 | 21000 | 26040 | 31080 | 33600 | 37380 | 40320 | 43680 | 46200 | 48720 |
| | 2250 | 18000 | 22500 | 27900 | 33300 | 36000 | 40050 | 43200 | 46800 | 49500 | 52200 |
| | 2400 | 19200 | 24000 | 29760 | 35520 | 38400 | 42720 | 46080 | 49920 | 52800 | 55680 |
| 2400 | 1200 | 11520 | 14400 | 17860 | 21310 | 23040 | 25630 | 27650 | 29950 | 31680 | 33400 |
| | 1350 | 12960 | 16200 | 20090 | 23980 | 25920 | 28840 | 31100 | 33670 | 35640 | 37580 |
| SIX | 1500 | 14400 | 18000 | 22320 | 26640 | 28800 | 32040 | 34560 | 37440 | 39600 | 41760 |
| MODULES | 1650 | 15840 | 19800 | 24550 | 29300 | 31680 | 35240 | 38020 | 41180 | 43560 | 45940 |
| | 1800 | 17280 | 21600 | 26780 | 31970 | 34560 | 38450 | 41470 | 44930 | 47520 | 50110 |
| | 1950 | 18720 | 23400 | 29020 | 34630 | 37440 | 41650 | 44930 | 48670 | 51480 | 54290 |
| | 2100 | 20160 | 25200 | 31250 | 37300 | 40320 | 44860 | 48380 | 52420 | 55440 | 58460 |
| | 2400 | 23040 | 28800 | 35710 | 42620 | 46080 | 51260 | 55300 | 59900 | 63360 | 66820 |

The pressure loss data above relates to a straight attenuator 1200mm long. The following factors are applicable to other lengths:

| Length 'L' (mm) | 600 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 |
|---|---|---|---|---|---|---|---|
| Δ p factor | x 0.90 | x0.95 | 0 | x1.05 | x1.10 | x1.15 | x1.20 |

For splitter bend attenuators add 50% to the pressure loss for the straight attenuator.

SILENCERS

SAFID سافيد

**Weight SA20 Cased Attenuator**

| Width (mm) | SA20-75 SA20-100 | 275 300 | 550 600 | 825 900 | 1100 1200 | 1325 1500 | 1650 1800 | 1925 2100 |
|---|---|---|---|---|---|---|---|---|
| | SA20-150 SA20-200 | 350 400 | 700 800 | 1050 1200 | 1400 1600 | 1750 2000 | 2100 - | - - |
| Number of Modules | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Length 'L' (mm) | Height 'H' (mm) | Weight (kg ± 10%) | | | | | | |
| 600 | 300 | 16 | 26 | 36 | 46 | 56 | 64 | 70 |
| | 600 | 23 | 36 | 49 | 62 | 75 | 87 | 95 |
| | 900 | 30 | 46 | 62 | 78 | 94 | 110 | 120 |
| | 1200 | 37 | 56 | 75 | 93 | 113 | 132 | 145 |
| | 1500 | - | 66 | 82 | 110 | 131 | 153 | 169 |
| | 1800 | - | - | 106 | 132 | 159 | 185 | 205 |
| 900 | 300 | 22 | 36 | 49 | 63 | 77 | 90 | 98 |
| | 600 | 31 | 49 | 66 | 84 | 102 | 119 | 130 |
| | 900 | 41 | 63 | 84 | 106 | 128 | 150 | 164 |
| | 1200 | 50 | 76 | 101 | 127 | 153 | 179 | 197 |
| | 1500 | - | 90 | 116 | 148 | 178 | 207 | 229 |
| | 1800 | - | - | 144 | 180 | 216 | 252 | 280 |
| 1200 | 300 | 26 | 44 | 61 | 79 | 97 | 115 | 123 |
| | 600 | 38 | 60 | 82 | 104 | 127 | 149 | 162 |
| | 900 | 50 | 78 | 106 | 133 | 161 | 189 | 207 |
| | 1200 | 63 | 95 | 127 | 160 | 192 | 225 | 248 |
| | 1500 | - | 113 | 149 | 186 | 224 | 261 | 289 |
| | 1800 | - | - | 182 | 227 | 273 | 319 | 355 |
| 1500 | 300 | 30 | 51 | 72 | 92 | 113 | 134 | 144 |
| | 600 | 44 | 70 | 96 | 121 | 147 | 173 | 188 |
| | 900 | 58 | 90 | 122 | 154 | 186 | 218 | 239 |
| | 1200 | 72 | 110 | 147 | 185 | 222 | 259 | 286 |
| | 1500 | - | 130 | 172 | 215 | 258 | 301 | 333 |
| | 1800 | - | - | 210 | 262 | 315 | 368 | 409 |
| 1800 | 300 | 42 | 70 | 95 | 122 | 150 | 176 | 193 |
| | 600 | 60 | 96 | 130 | 165 | 201 | 235 | 256 |
| | 900 | 80 | 124 | 166 | 208 | 252 | 297 | 325 |
| | 1200 | 98 | 150 | 199 | 250 | 301 | 355 | 390 |
| | 1500 | - | 178 | 230 | 293 | 351 | 411 | 454 |
| | 1800 | - | - | 284 | 355 | 427 | 500 | 554 |
| 2100 | 300 | 46 | 78 | 108 | 140 | 172 | 203 | 219 |
| | 600 | 67 | 107 | 146 | 186 | 227 | 265 | 290 |
| | 900 | 89 | 138 | 187 | 236 | 286 | 335 | 365 |
| | 1200 | 110 | 167 | 225 | 284 | 340 | 400 | 440 |
| | 1500 | - | 200 | 261 | 330 | 398 | 464 | 513 |
| | 1800 | - | - | 322 | 401 | 485 | 565 | 629 |

**Weight SAS Splitters Only**

| Width in Modules | | One Module | Each Additional Modules |
|---|---|---|---|
| Length 'L' (mm) | Height 'H' (mm) | Weight (kg ± 10%) | |
| 600 | 300 | 6 | 5 |
| | 600 | 10 | 8 |
| | 900 | 14 | 10 |
| | 1200 | 17 | 13 |
| | 1500 | 20 | 15 |
| | 1800 | 27 | 17 |
| 900 | 300 | 9 | 7 |
| | 600 | 14 | 10 |
| | 900 | 20 | 14 |
| | 1200 | 25 | 18 |
| | 1500 | 30 | 21 |
| | 1800 | 39 | 25 |
| 1200 | 300 | 11 | 8 |
| | 600 | 17 | 13 |
| | 900 | 25 | 18 |
| | 1200 | 34 | 23 |
| | 1500 | 42 | 27 |
| | 1800 | 55 | 31 |
| 1500 | 300 | 13 | 10 |
| | 600 | 21 | 16 |
| | 900 | 30 | 22 |
| | 1200 | 34 | 28 |
| | 1500 | 51 | 32 |
| | 1800 | 66 | 38 |
| 1800 | 300 | 17 | 11 |
| | 600 | 28 | 19 |
| | 900 | 39 | 25 |
| | 1200 | 55 | 32 |
| | 1500 | 66 | 37 |
| | 1800 | 78 | 45 |
| 2100 | 300 | 19 | 13 |
| | 600 | 30 | 19 |
| | 900 | 44 | 28 |
| | 1200 | 61 | 35 |
| | 1500 | 75 | 44 |
| | 1800 | 88 | 52 |

**NOTE:**
The data below should not be used where Melinex (polyester membrane) faced attenuators are rquired, since the use of the membrane modifies acoustic performance. Performance requirements higher than shown in Table 3 should be referred to SAFID for selection.

**W = 2100mm** **H = 1800mm** **L = 2100mm**

**Nomenclature:**

**W in mm :** Width inside duct.
**H in mm :** Height in duct.
**L in mm :** Length
**d in cm :** Splitter thickness
**s in mm :** Airway width.
**V in l/s :** Volume flow rate.
**$v_t$ in m/s :** Face velocity based on V ÷ (W x H x 1000).
**Δp in Pa :** Pressure loss.
**$f_m$ in Hz :** Octave centre frequency.
**$d_e$ in dB :** Insertion loss.
**NC in dB :** Noise criterion







SAFID سافيد



## Order Details

**Order Code for Cased Attenuator** SA / M / 20-100 / EP / 1800 x 1200 x 900

Attenuator Type

Type Suffix:

- O: Standard
- H: Horizontal Airways
- HP: High Pressure Casing
- M: Melinex infill wrap
- BV: Bend Vertical
- BH: Bend Horizontal
- AF: Angle Flange Connections
- X: Evase Tail
- U: Without perforated sheet

Splitter thickness in cm

Airways in mm

Material Finish:

- O: Standard
- SS-304: Stainless Steel Grade 304
- SS-316: Stainless Steel Grade 316
- EP: Epoxy Painted (both surfaces)
- EPI: As above, internal surfaces only
- EPE: As above, external surfaces only

Height in mm
Width in mm
Length in mm

**Order Code for Splitter** SAS / M / 20-100 / EP / 1800 x 1200 x 900

Attenuator Type

Type Suffix:

- O: Standard
- H: Horizontal Airways
- M: Melinex infill wrap

Splitter thickness in cm

Airways in mm

Material Finish:

- O: Standard
- SS-304: Stainless Steel Grade 304
- SS-316: Stainless Steel Grade 316
- EP: Epoxy Painted (both surfaces)

Height in mm
Width in mm
Length in mm

### Specifications

**Cased Attenuators**
Type SA splitter attenuator, incorporating aerodynamic splitters and side liners with erosion protected Class O acoustic infill covered by perforated sheet metal. Casing construction conforms with SMACNA & DW 144 Standards. Flange connections are SAF -30 or SAF - 35 slide on type.

**Splitters Only**
Type SAS splitters only, for installation in ductwork by others, featuring aerodynamic leading and trailing edges with erosion protected Class O acoustic infill covered by galvanized perforated sheet metal. The splitter frame is manufactured from Ga.20 galvanized sheet metal.

### Order Example

**Standard For Sound Attenuator**
**Make :** SAFID
**Type :** SA20-100 / 1800 × 1200 × 900
**Qty :** 1

**Standard For Splitter**
**Make :** SAFID
**Type :** SAS20-100 / 1800 × 1200 × 900
**Qty :** 1









## INTRODUCTION TO CYNDRICAL SOUND ATTENUATORS

### Introduction

For many years noise was something to be tolerated. Unpleasant perhaps, but no more than that.

While it has been recognised for many years that the exposure of work-people to noise is hazardous and that noise-induced hearing loss cannot be corrected to any significant degree by means of medical treatment. The cost of ignoring noise is the impaired hearing of factory workers, an inability to work properly under almost unbearable sound levels, and a whole variety of social effects.

In schools, offices, hospitals, noise can interfere with communication and disrupts concentration.
In any building project where consideration is given to the internal or external acoustic environments, it is necessary to formulate certain targets at the preliminary planning stages in order that desired comfort conditions are attained.

Mechanical equipment noise is one of the major sources of unwanted noise in a building. The primarily considerations given to the selection and use of mechanical equipment in buildings have generally been only those directly related to the intended use of the equipment. However, with the trend towards light weight building structures and variable-volume air distribution systems, the noise generated by mechanical equipment and the design of equipment spaces should not only be undertaken with an emphasis on the intended uses of the equipment, but also with a desire to provide acceptable noise levels in the occupied spaces of the building in which the equipment is located.

### Test Method

All SAFID attenuators are tested in accordance with BS 4718 : 1971.

The laboratory measurement of insertion loss is defined as the arithmetic difference in the sound level of an electronically generated noise produced upstream of the test sample location with and without the test sample installed, when measured downstream of the test sample location.

The test ducting is assembled such that one end is located into a plenum containing the sound source and the outlet is fed into the 300 cubic metres reverberation room.

Static insertion loss is measured by placing a speaker in the duct and then measuring the noise levels in the test chamber with and without the attenuator. The difference between the measurements is calculated to give the insertion loss.

For the regenerated noise, measurements are made of the noise generated by air flowing through the duct system alone. Part of the duct work is then replaced by attenuator and the noise is measured again. The noise due to this system is then deducted from the noise measured with the attenuator to give the regenerated noise due solely to the attenuator.

## SAC

### Description

The cylindrical attenuators are prefabricated sections of double wall ductwork with solid outer shell and perforated inner shell. The space between the two shells are usually filled with acoustic infill. It is designed for reducing fan noise, meeting specified noise levels such as NC or NR.

### Construction

Type SAC attenuators are available in a size range based upon ISO standards. Two lengths are catalogued, nominally equivalent to one times inside duct diameter with increased lengths available where higher acoustic performance is required. Alternative sizes and end connection types can be provided.

Standard attenuator casings are manufactured from galvanized sheet metal Ga.20 minimum. Casings are constructed with grooved seams with a mastic sealant; casing thickness complies with SMACNA standards and DW 144 Class B ductwork code. End plates contain threaded inserts M6-M10 as standard depending upon attenuator size. The attenuators contain acoustic infill has a glass cloth facing and is contained behind galvanized perforated sheet metal; this dual protection prevents damage and fibre erosion up to 30 m/s airway velocity.

### Alternative Construction

**SACH**
Type SACH; as for type SAC but with the casing thickness increased to comply with ductwork codes SMACNA standards - high pressure and DW 144 Class C or D.

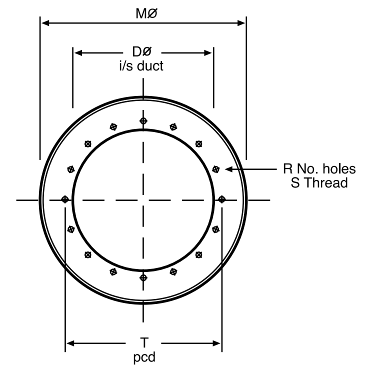
**SACM**
Type SACM; as for type SAC but the acoustic infill is enveloped in a Melinex polyester film.

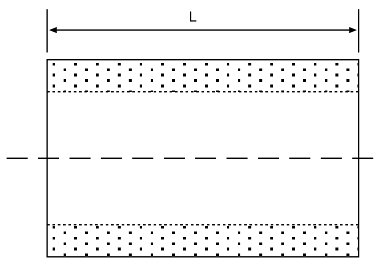
### Sectionalised Construction

Attenuators would normally be supplied split on length when the “L” dimension exceeds 2000mm, for site assembly by others. Coupling angles are supplied.

The assembly of sectionalised attenuators is on site, by others. SAFID will provide full details of attenuator configuration and assembly.

### Dimensions



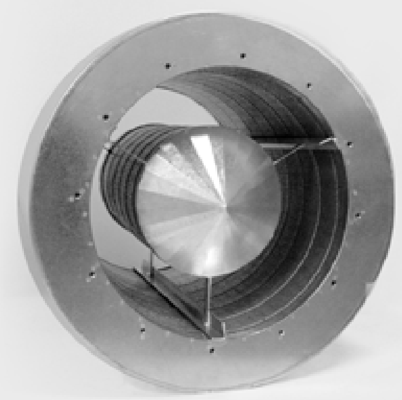

SILENCERS







## SACP



### Description

The podded cylindrical attenuators are prefabricated sections of double wall ductwork with solid outer shell, perforated inner shell and incorporates an aerodynamically efficient concentric pod. The space between the two shells and pod are usually filled with acoustic infill. It is designed for reducing fan noise, meeting specified noise levels such as NC or NR.

### Construction

Type SACP attenuators are available in a size range based upon ISO standards. Two lengths are catalogued, nominally equivalent to one times inside duct diameter with increased lengths available where higher acoustic performance is required. Alternative sizes and end connection types can be provided.

Standard attenuator casings are manufactured from galvanized sheet metal Ga.20 minimum. Casings are constructed with grooved seams with a mastic sealant; casing thickness complies with SMACNA standards and DW 144 Class B ductwork code. End plates contain threaded inserts M6-M10 as standard depending upon attenuator size. The attenuators contain acoustic infill has a glass cloth facing and is contained behind galvanized perforated sheet metal; this dual protection prevents damage and fibre erosion up to 30 m/s airway velocity.

### Alternative Construction

**SACPH**
Type SACPH; as for type SACP but with the casing thickness increased to comply with ductwork codes SMACNA standards - high pressure and DW 144 Class C or D.

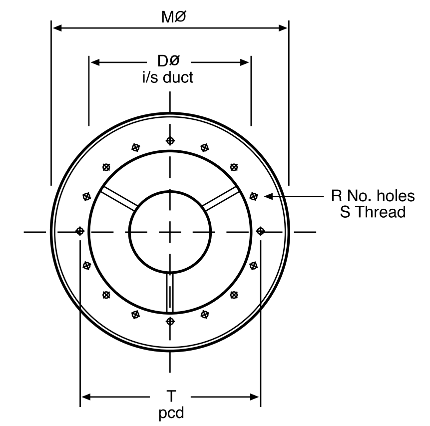
**SACPM**
Type SACPM; as fo type SAC but the acoustic infill is enveloped in a Melinex polyester film.

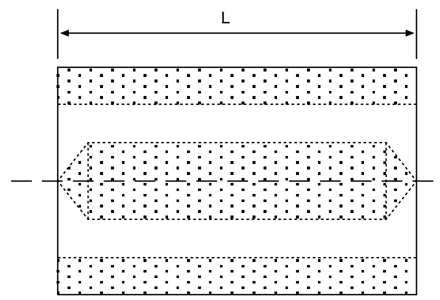
### Sectionalised Construction

Attenuators would normally be supplied split on length when the “L” dimension exceeds 2000mm, for site assembly by others. Coupling angles are supplied.

The assembly of sectionalised attenuators is on site, by others. SAFID will provide full details of attenuator configuration and assembly.

### Dimensions




SILENCERS

SAFID سافيد

## Acoustic Performance

**Performance**
Attenuator performance is derived from tests meeting the requirements of BS 4718 : 1971.

Cylindrical attenuators follow a similar principle, however, in this case the splitter consisting of a pod in the middle of a lined cylindrical duct.

Attenuator selection is based on the static insertion loss performance, the aerodynamic resistance or pressure drop, and the regenerated sound power levels. Static insertion loss figures are given in the table.

Full regenerated noise data is available for SAFID cylindrical attenuators, to enable installed Insertion Loss to be calculated.

Pressure loss data relates to pod type attenuators and assumes that the airflow to the attenuator is uniform over the face, in a duct to duct layout. Units installed in situations leading to poor inlet or discharge conditions could incur pressure drops higher than catalogued. Podless attenuators have a pressure loss similar to an equivalent length of ductwork.

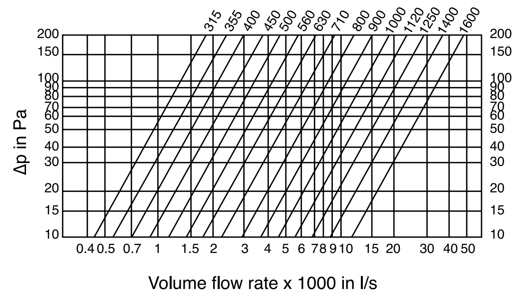
For insertion loss data for Melinex faced attenuators - refer to SAFID.

## Nomenclature

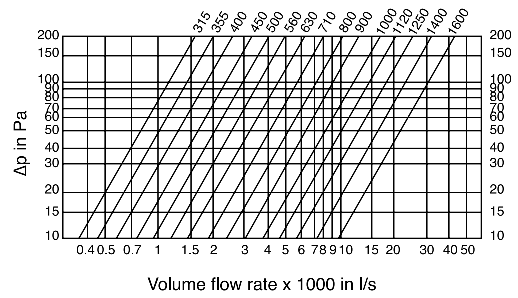
**L in mm :** Length
**D in mm :** Inside diameter
**V in l/s :** Volume flow rate
**Δp in Pa :** Pressure loss
**$f_m$ in Hz :** Octave centre frequency
**$D_e$ in dB :** Insertion loss

## Pressure Loss

Pressure loss for type SACP-1D




Pressure loss for type SACP-2D










SAFID سافيد



## Acoustic Performance

| Insertion Loss (dB) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Attenuator | | Octave Centre Frequency (Hz) | | | | | | | |
| Size | Type | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 250 | SAC-1D | 2 | 3 | 6 | 11 | 12 | 7 | 6 | 4 |
| | SAC-2D | 4 | 5 | 10 | 21 | 22 | 13 | 10 | 8 |
| 315 | SAC1-D | 2 | 3 | 6 | 12 | 11 | 7 | 6 | 4 |
| 355 | | | | | | | | | |
| 400 | SAC2-D | 4 | 5 | 10 | 21 | 22 | 13 | 10 | 8 |
| 450 | | | | | | | | | |
| | SACP-1D | 5 | 6 | 10 | 16 | 22 | 24 | 20 | 15 |
| | SACP-2D | 9 | 12 | 18 | 30 | 44 | 48 | 38 | 29 |
| 500 | SAC-1D | 2 | 3 | 6 | 11 | 12 | 7 | 6 | 4 |
| 560 | | | | | | | | | |
| 630 | SAC-2D | 4 | 5 | 10 | 21 | 20 | 10 | 9 | 6 |
| 710 | | | | | | | | | |
| 800 | SACP-1D | 5 | 6 | 10 | 16 | 22 | 23 | 17 | 12 |
| 900 | | | | | | | | | |
| | SACP-2D | 9 | 12 | 18 | 30 | 44 | 45 | 33 | 24 |
| 1000 | SAC-1D | 2 | 3 | 6 | 11 | 8 | 5 | 4 | 3 |
| 1120 | | | | | | | | | |
| 1250 | SAC-2D | 4 | 5 | 10 | 21 | 16 | 9 | 8 | 5 |
| 1400 | | | | | | | | | |
| 1600 | SACP-1D | 5 | 6 | 10 | 16 | 22 | 22 | 15 | 11 |
| | SACP-2D | 9 | 12 | 18 | 30 | 44 | 42 | 29 | 21 |

## Weights

| Dimensions (End Plate for Flange Connection) | | | | | | | | Weights (kg) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit Size | D f | M f | L 1D | L 2D | T pcd | R No. of Holes | S Thread Size | SAC 1D | SAC 2D | SACP 1D | SACP 2D |
| 250 | 256 | 456 | 250 | 500 | 286 | 6 | M6 | 9 | 13 | - | - |
| 315 | 322 | 522 | 300 | 600 | 356 | 8 | M8 | 11 | 15 | 14 | 20 |
| 355 | 361 | 561 | 350 | 700 | 395 | 8 | M8 | 15 | 21 | 20 | 28 |
| 400 | 404 | 604 | 400 | 800 | 438 | 12 | M8 | 18 | 27 | 26 | 36 |
| 450 | 453 | 653 | 450 | 900 | 487 | 12 | M8 | 24 | 35 | 34 | 42 |
| 500 | 507 | 707 | 500 | 1000 | 541 | 12 | M8 | 29 | 41 | 41 | 57 |
| 560 | 564 | 764 | 550 | 1100 | 605 | 16 | M10 | 35 | 50 | 50 | 70 |
| 630 | 638 | 838 | 600 | 1200 | 674 | 16 | M10 | 42 | 58 | 58 | 82 |
| 710 | 715 | 915 | 700 | 1400 | 751 | 16 | M10 | 51 | 72 | 72 | 100 |
| 800 | 801 | 1001 | 800 | 1600 | 837 | 24 | M10 | 58 | 82 | 79 | 111 |
| 900 | 898 | 1098 | 900 | 1800 | 934 | 24 | M10 | 70 | 100 | 97 | 135 |
| 100 | 1007 | 1207 | 1000 | 2000 | 1043 | 24 | M10 | 95 | 135 | 120 | 185 |
| 1120 | 1130 | 1330 | 1100 | 2200 | 1174 | 24 | M10 | 115 | 160 | 145 | 215 |
| 1250 | 1267 | 1467 | 1250 | 2500 | 1311 | 24 | M10 | 130 | 180 | 165 | 240 |
| 1400 | 1421 | 1622 | 1400 | 2800 | 1465 | 24 | M10 | 210 | 420 | 270 | 520 |
| 1600 | 1593 | 1793 | 1600 | 3200 | 1637 | 32 | M10 | 250 | 490 | 320 | 620 |

SAFID

## Order Details

**Order Code** SAC / 2D / 630 / H / SS-304

**Attenuator Type:**
- SAC without pod
- SACP with Pod

**Attenuator Length:**
- 1D; nominally 1 times diameter
- 2D; nominally 2 times diameter

**Attenuator Size**

**Construction:**
- O: Standard
- H: High Pressure Casing
- M: Melinex Infill Wrap

**Material Finish:**
- O: Standard
- SS-304: Stainless Steel Grade 304
- SS-316: Stainless Steel Grade 316
- EP: Epoxy Painted (both surfaces)
- EPI: As above, internal surfaces only
- EPE: As above, external surfaces only
- GAM: manufacture casing and perforated facing

## Specification Text

Type SAC/SACP cylindrical attenuators incorporating erosion protected Class O acoustic infill covered by perforated sheet metal. The casing is manufactured to DW 144 Class B medium pressure construction from galvanized sheel metal of the appropriate thickness. End plates fitted with threaded nut inserts.

## Order Example

**Make :** SAFID
**Type :** SAC-2D/630/HP/SS-304
**Qty :** 1







SAFID



## Introduction

The fan is not the only source of airborne sound power which can be transmitted through ductworks. Just as sound power can come out of ducts through air devices in rooms, it can also enter these openings. If two rooms are served by branches on a common duct system or if walls or partitions has air transfer openings, the greater possibility of sound to transmit from one room to adjoining room. Sound in one room which can be transmitted to adjoining room may came from many sources such as raised voice, office equipments or machinery. This sound path is called crosstalk. A suitable method of preventing or reducing crosstalk to attain the required room noise level is by installing crosstalk attenuator.

## Application

The crosstalk attenuators are commonly used to prevent noise transmission via common ceiling, duct system or in air transfer openings on walls or partitions between adjoining rooms.

These units are designed and built for optimum noise control in a situation where the noise in the first room is clearly heard in the second room.

SAFID


## Description

The crosstalk attenuators are prefabricated sections of ductwork with acoustic lining.

It is designed to avoid noise radiated from a room or from a duct termination which is connected via a main duct, to a branch duct leading to another room. Airflow is permitted whilst noise transfer is limited.

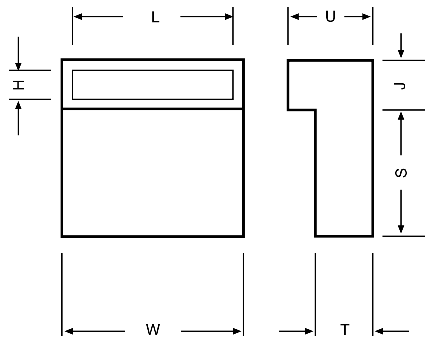
## Construction

Type SCTL attenuators have been designed to avoid noise interference between interconnected rooms. It is used as air transfer attenuators between adjoining areas where the acoustic integrity of a common partition or ceiling needs to be maintained.

Casing are manufactured from galvanized sheet metal Ga.20, with spot welded seams. The acoustic lining complies with Class O Building Regulations and has a glass tissue facing for erosion protection. The units may be supplied with one or two eggcrated grilles in natural anodised aluminium. Colour paint finishes are available to order.

## Dimensions

Type SCTL

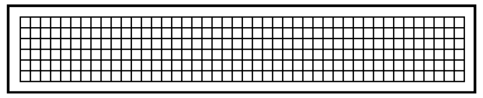



## Standard Sizes

| Unit Size | H | L | J | W | T | U | S |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 550 | 140 | 590 | 100 | 120 | 760 |
| 2 | 100 | 700 | 140 | 740 | 100 | 120 | 760 |
| 3 | 100 | 900 | 140 | 940 | 100 | 120 | 760 |
| 4 | 100 | 1000 | 140 | 1040 | 100 | 120 | 760 |
| 5 | 100 | 1200 | 140 | 1240 | 100 | 120 | 760 |

**<u>Optional Grilles:</u> Eggcrate Pattern**

Standard Supply: For Type SCTL One no.









SAFID




## Description

The crosstalk attenuators are prefabricated sections of ductwork with acoustic lining.

It is designed to avoid noise radiated from a room or from a duct termination which is connected via a main duct, to a branch duct leading to another room. Airflow is permitted whilst noise transfer is limited.

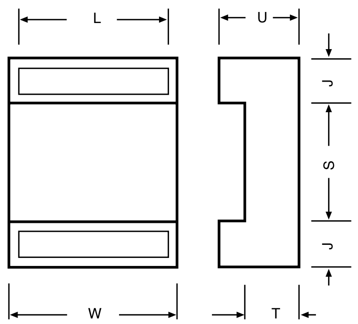
## Construction

Type SCTU attenuators have been designed to avoid noise interference between interconnected rooms. It is used as air transfer attenuators between adjoining areas where the acoustic integrity of a common partition or ceiling needs to be maintained.

Casing are manufactured from galvanized sheet metal Ga.20, with spot welded seams. The acoustic lining complies with Class O Building Regulations and has a glass tissue facing for erosion protection. The units may be supplied with one or two eggcrated grilles in natural anodised aluminium. Colour paint finishes are available to order.

## Dimensions

Type SCTU

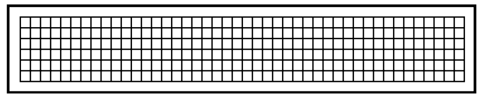



## Standard Sizes

| Unit Size | H | L | J | W | T | U | S |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 550 | 140 | 590 | 100 | 120 | 760 |
| 2 | 100 | 700 | 140 | 740 | 100 | 120 | 760 |
| 3 | 100 | 900 | 140 | 940 | 100 | 120 | 760 |
| 4 | 100 | 1000 | 140 | 1040 | 100 | 120 | 760 |
| 5 | 100 | 1200 | 140 | 1240 | 100 | 120 | 760 |

**<u>Optional Grilles:</u> Eggcrate Pattern**

Standard Supply: For Type SCTU Two no.



SCTZ

SCT Series

## Description

The crosstalk attenuators are prefabricated sections of ductwork with acoustic lining.

It is designed to avoid noise radiated from a room or from a duct termination which is connected via a main duct, to a branch duct leading to another room. Airflow is permitted whilst noise transfer is limited.

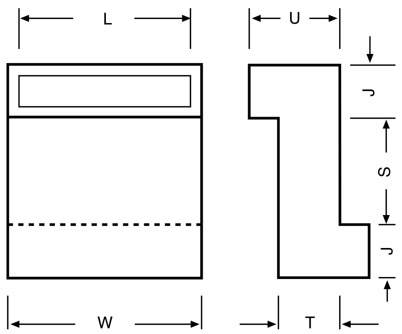
## Construction

Type SCTZ attenuators have been designed to avoid noise interference between interconnected rooms. It is used as air transfer attenuators between adjoining areas where the acoustic integrity of a common partition or ceiling needs to be maintained.

Casing are manufactured from galvanized sheet metal Ga.20, with spot welded seams. The acoustic lining complies with Class O Building Regulations and has a glass tissue facing for erosion protection. The units may be supplied with one or two eggcrated grilles in natural anodised aluminium. Colour paint finishes are available to order.

## Dimensions

Type SCTZ

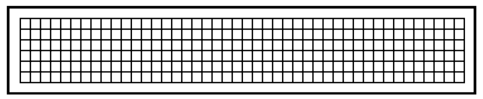



## Standard Sizes

| Unit Size | H | L | J | W | T | U | S |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 550 | 140 | 590 | 100 | 120 | 760 |
| 2 | 100 | 700 | 140 | 740 | 100 | 120 | 760 |
| 3 | 100 | 900 | 140 | 940 | 100 | 120 | 760 |
| 4 | 100 | 1000 | 140 | 1040 | 100 | 120 | 760 |
| 5 | 100 | 1200 | 140 | 1240 | 100 | 120 | 760 |

**Optional Grilles:** Eggcrate Pattern

Standard Supply: For Type SCTZ Two No.





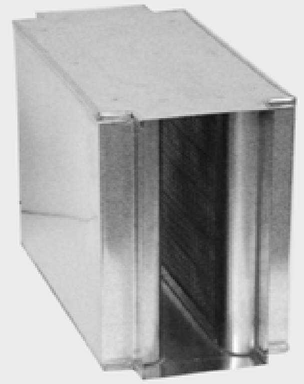




CROSSTALK ATTENUATOR

SCT 100 - 1
SCT 100 - 2
SCT 100 - 3
SCT 100 - 4

SCT Series



## Description

Prefabricated crosstalk attenuators Type SCTS and SCTBH with aerodynamic acoustic side liners has a high insertion loss designed to attenuate the airborne noise transmitted from a room to adjoining room through a duct termination which is connected to a common air duct system or through air transfer openings on walls or partions. Crosstalk attenuator will allow to pass the required airflow whilst noise transfer will be limited meeting the designed noise level in the occupied space.

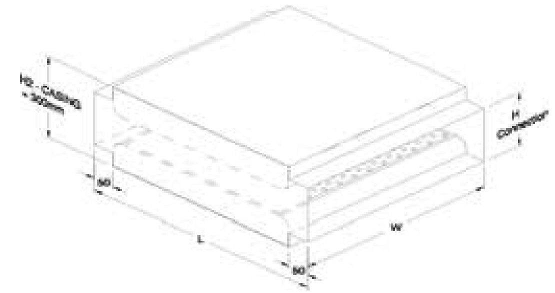
## Construction

The casing and side liners are manufactured from galvanized sheet metal Ga.20. Casing is with lock formed seams, with mastic sealant. The construction complies with SMACNA and DW 144 standards. With spigot connections are supplied as standard.

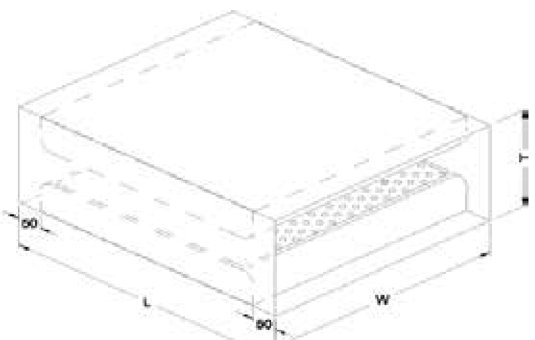
The aerodynamic acoustic side liners contain acoustic infill which complies with Class O Building regulations. The infill has a glass tissue facing and is contained behind galvanized perforated sheet metal. This dual protection prevents damage and fiber erosion up to 30 m/s airway velocity. The side liners are radiussed at both ends to minimize air pressure loss and regenerated noise.

## Dimensions

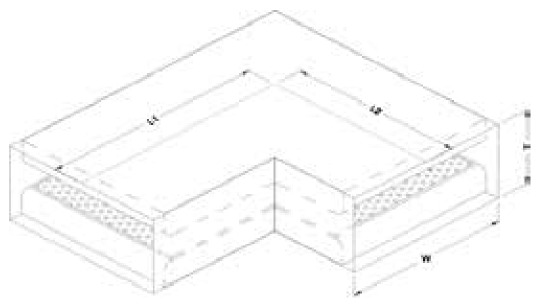
**Type SCTS 100 - 1, SCTS 100 - 2, SCTS 100 -3, SCTS 100 -4**



**Type SCTS 100, SCTS 200**




**Type SCTS 100, SCTS 200**
**L = L1 + L2**



SILENCERS

## ATTENUATOR PERFORMANCE

**Type SCTL - SCTU - SCTZ**
The acoustic performance of Type SCTL, SCTU and SCTZ is designed to maintain the acoustic intergrity of a single thickness brick wall. Selection procedure is accordingly independent of source noise levels and noise requirements in the receiving room.

Pressure loss data includes an allowance for the use of standard eggcrate grilles. Alternative grille types are likely to increase resistance to airflow.

Table 2 incorporates guide figures from maximum pressure loss against design noise level requirements, in order to limit attenuator self noise. These are shown as space noise criterion (NC) levels with 8dB room absorption.

**Type SCTS and SCTBH**
The acoustic performance of type SCTS and SCTBH is derived from tests meeting the requirements of BS 4718: 1971.

No deviations of insertion loss with airflow were recorded over the velocities employed in this brochure. The Static Insertion Loss figures are given in Table 3.

The total noise reduction figures shown in Table 3 gives an indication of the total room to room noise reduction that could be expected with a typical duct layout or with air transfer openings on walls or partitions. (Similar to Sound Reduction Index for a partition).

Table 5 incorporates guide figures for maximum duct velocity against design noise level requirements, in order to limit attenuator self noise. These are shown as space noise criterion (NC) levels with 8dB room absorption. Full regenerated noise data for SCTS attenuators, is available upon request.

Pressure loss data assumes that the airflow to the attenuator is uniform over the face, in a duct-to-duct layout. Units installed in situations leading to poor inlet or discharge conditions could incur pressure lossess higher than losses mentioned in the catalogue.

**Table 1: Recommended Design Noise Criteria for Various Area Functions**

| Type of Room | NC |
|---|---|
| **Section 1 - Studios and Auditoria** | |
| Sound Broadcasting (general), TV (general), Recording Studio | 20 |
| TV (audience studio) | 25 |
| Concert Hall, Theatre | 20 - 25 |
| Lecture Theatre, Cinema | 25 - 30 |
| **Section 2 - Hospitals** | |
| Audiometric Room | 20 - 25 |
| Operating Theatre, Single Bed Ward | 30 - 35 |
| Multi-bed Ward, Waiting room | 35 |
| Corridor, Laboratory | 35 - 40 |
| Staff Room, Recreation Room | 30 - 40 |
| **Section 3 - Hotels** | |
| Individual Room, Suite | 20 - 30 |
| Ballroom, Banquet Room | 30 - 35 |
| Corridor, Lobby | 35 - 40 |
| **Section 4 - Offices** | |
| Boardroom, Large Conference Room | 25 - 30 |
| Small Conference Room, Executive Office, Reception Room | 30 - 35 |
| Open Plan Office | 35 |
| Drawing office, Computer Suite | 35 - 45 |
| **Section 5 - Offices** | |
| Bedroom | 25 |
| Living Room | 30 |







## SCTL, SCTU AND SCTZ

### Method of Selection

**Type SCTL - SCTU - SCTZ**

1. Select a suitable design NC level from Table 1.

2. For required volume flow rate, select from Table 2 a unit size for an acceptable pressure loss (typically 20 Pa).

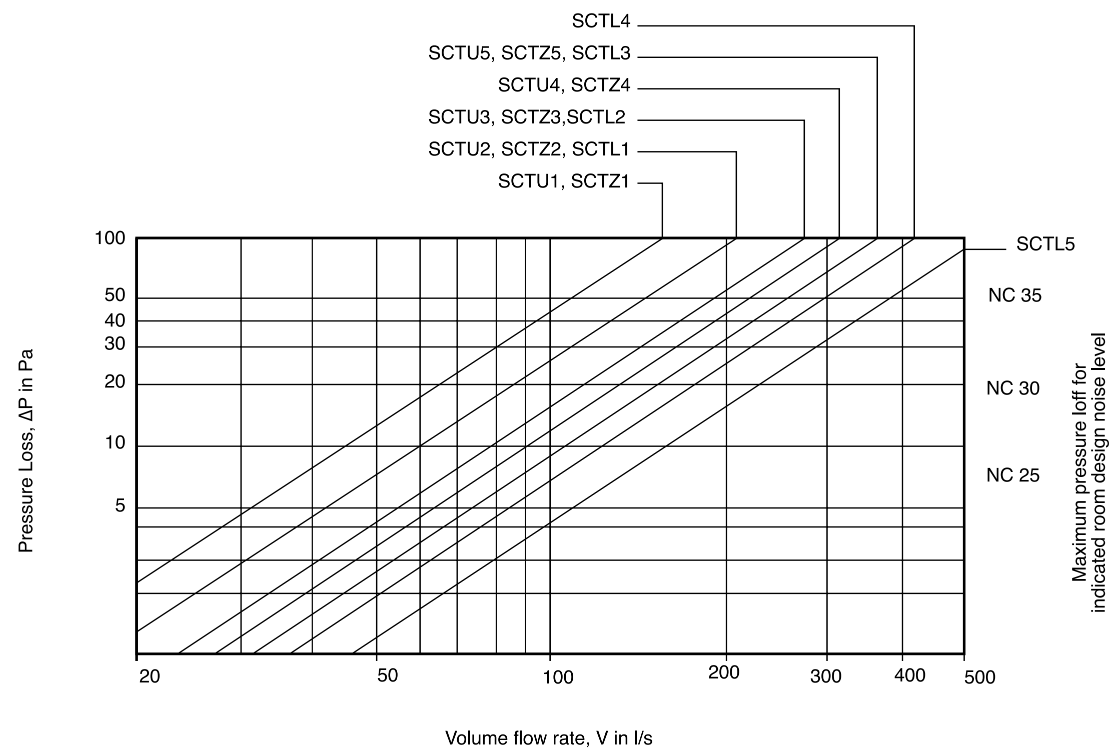
3. Ensure that the pressure loss is kept within the guide limit for the design room NC level.

4. Check unit dimensions for each model.situations leading to poor inlet or discharge conditions could incur pressure lossess higher than losses mentioned in the catalogue.

**Table 2: Pressure Loss for Indicated Room Design Noise Level Requirements**

### Nomenclature

**W in mm :** Width inside duct.
**H in mm :** Height in duct.
**L in mm :** Length
**V in l/s :** Volume flow rate.
**$v_t$ in m/s :** Face velocity based on V ÷ (W x H x 1000).
**Δp in Pa :** Pressure loss.
**$f_m$ in Hz :** Octave centre frequency.
**$D_e$ in dB :** Insertion loss.
**NC in dB :** Noise criterion



## SCT SERIES

### Quick Selection

**Type SCTS 100 - 1, SCTS 100 - 2, SCTS 100 - 3, SCTS 100 - 4**

The quick selection method provides an attenuator selection for the control of speech crosstalk between rooms linked by a common duct system. The noise source has been taken as a "voice as loud as possible without strain" - approximately NC75/80dBA in a typical office environment. Attenuator length required depends upon the design background noise level for the receiving room.

1. Select a suitable design NC level from Table 1.

2. From Table 4 select the attenuator length shown against the NC level appropriate for the type of room being considered.

3. Using Table 5, select a cross section for the required volume flow rate and pressure loss/velocity. Discharge conditions could incur pressure lossess higher than catalog.

### Full Selection

**Type SCTS 100 - 1, SCTS 100 - 2, SCTS 100 - 3, SCTS 100 - 4**

When an attenuator performance requirement has been established following accurate acoustic analysis of source noise, transmission path and receiving room requirements, a suitable SCTS attenuator can be selected as follows.

1. From Table 3 select an attenuator length to meet the required insertion loss.

2. Check the Self Noise guide on Table 5 to determine the maximum velocity for the room NC level required (consult Table 1).

3. Using Table 5, select a cross section for the required volume flow rate and pressure loss/velocity.

**Table 3: Insertion Loss ($D_e$ in dB) - Type SCTS and SCTBH**

| Attenuator Length 'L' (mm) | Octave Centre Frequency ($f_m$ in Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 500 | 5 | 7 | 10 | 15 | 23 | 17 | 13 | 11 |
| 750 | 6 | 9 | 14 | 23 | 37 | 29 | 22 | 16 |
| 1000 | 8 | 11 | 19 | 31 | 48 | 37 | 28 | 21 |
| 1250 | 9 | 14 | 23 | 38 | 50 | 44 | 32 | 26 |
| 1500 | 10 | 16 | 27 | 45 | 50 | 50 | 39 | 31 |

SILENCERS







## SCT SERIES

**Table 4: Quick Selection**

| Design Noise Criterion in Noise Critical Area | Attenuator Length Required (mm) | Total Noise Reduction at 500 Hz (dB) |
|---|---|---|
| NC 45 | 500 | 20 |
| NC 40 | 750 | 28 |
| NC 35 | 1000 | 36 |
| NC 30 | 1250 | 43 |
| NC 25 | 1500 | 50 |

**Table 5: Pressure Loss for Indicated Room Design Noise Level Requirements**

| Attenuator Type | Air Velocity ($v_t$ in m/s at duct size W x H) | | 2.0 | 3.0 | 4.0 | 5.0 |
|---|---|---|---|---|---|---|
| | Self Noise Guide against Velocity | | NC 25 | NC 30 | NC 35 | NC 40 |
| | Width 'W' (mm) | Height 'H' (mm) | Volume Flow Rate (litre/second) | | | |
| SCTS 100-1 | 100 | 100 | 20 | 30 | 40 | 50 |
| | 150 | 100 | 30 | 45 | 60 | 75 |
| | 200 | 100 | 40 | 60 | 80 | 100 |
| Pressure loss (Δp in Pa) | | | < 5 | < 5 | 6 | 10 |
| SCTS 100-2 | 100 | 150 | 30 | 45 | 60 | 75 |
| | 150 | 150 | 45 | 70 | 90 | 115 |
| | 200 | 150 | 60 | 90 | 120 | 150 |
| | 250 | 150 | 75 | 115 | 150 | 190 |
| | 300 | 150 | 90 | 135 | 180 | 225 |
| Pressure loss, (Δp in Pa) | | | < 5 | 8 | 14 | 22 |
| SCTS 100-3 | 100 | 200 | 40 | 60 | 80 | 100 |
| | 150 | 200 | 60 | 90 | 120 | 150 |
| | 200 | 200 | 80 | 120 | 160 | 200 |
| | 250 | 200 | 100 | 150 | 200 | 250 |
| | 300 | 200 | 120 | 180 | 240 | 300 |
| | 350 | 200 | 140 | 210 | 280 | 350 |
| | 400 | 200 | 160 | 240 | 320 | 400 |
| Pressure loss (Δp in Pa) | | | 6 | 14 | 25 | 39 |
| SCTS 100-4 | 100 | 250 | 50 | 75 | 100 | 125 |
| | 150 | 250 | 75 | 115 | 150 | 190 |
| | 200 | 250 | 100 | 150 | 200 | 250 |
| | 250 | 250 | 125 | 190 | 250 | 315 |
| | 300 | 250 | 150 | 225 | 300 | 375 |
| | 350 | 250 | 175 | 265 | 350 | 440 |
| | 400 | 250 | 200 | 300 | 400 | 500 |
| | 500 | 250 | 250 | 375 | 500 | 625 |
| Pressure loss (Δp in Pa) | | | 10 | 22 | 39 | 60 |

**NOTE** The total noise reduction at 500 Hz shown in Table 4 includes 5dB room absoption.

SILENCERS

## Order Details

**Order Code**
For ceiling, wall/partiton mounting attenuator:
These codes do not need to be completed for standard products.

SCTL / 4 / 0 / S1 / S2

**Attenuator Type:**
SCTL
SCTU
SCTZ

**Unit Size 1 to 5**

**No Grille: 0**

**Fitted with RAG grilles: 1**

**Casing Finish**
O: Galvanized Sheet (Standard)
S1: Painted according to RAL
S2: Painted according to BS

**Casing Finish**
Z0: Powder coated, white RAL 9010 (Standard).
Z1: Natural anodized aluminium finish.
Z2: Any other color if requested as specified.

**Order Code**
For ceiling, wall/partiton mounting attenuator:

SCTS / 100-4 / 350 x 250 x 1000

**Attenuator Type:**
SCTL
SCTBH

**Unit Size 1 to 4**
**100 - 200**

Length in mm
Height (Connection) in mm
Width in mm

### Specifications

**Attenuator Type SCTL · SCTU · SCTZ**
Type SCTL, SCTU or SCTZ crosstalk attenuator, incorporating erosion protected Class O acoustic infill. The casing is manufactured from Ga.20 galvanized steel sheet metal with spot welded seams.

Attenuators may be supplied with standard Return Air Grilles (RAG) if required.

**For Duct, Wall/Partition Mounting:**
Attenuator Type SCTS and SCTBH
Type SCTS or SCTBH crosstalk attenuator, incorporating aerodynamic side liners with erosion protected Class O acoustic infill covered by perforated sheet metal. The attenuator casing is manufactured to DW 144 Class B medium pressure cosntruction from Ga.20 galvanized steel sheet metal. The attenuators are provided with spigot end connections.

### Order Example

**For Ceiling Wall/Partition Mounting:**
**Make :** SAFID
**Type :** SCTL-4/0
**Qty :** 1

**For Duct Wall/Partition Mounting:**
**Make :** SAFID
**Type :** SCTS 100-4 / 350 × 250 × 1000
**Qty :** 1









SRL

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6 December 2001

**C/01/5L/0121/L12A/JTD/mth**

Mr Jamal Jawhari
Saudi Air Distribution Systems Co. Ltd (SAFID)
P O Box 15300
Riyadh 11444
Kingdom of Saudi Arabia

Dear Mr Jawhari

### Attenuator Tests - Catalogue Data

We have completed our calculations and extrapolations of the attenuator SIL test data. The table attached (Appendix A) contains the data for inclusion in the catalogue for the 4 types of attenuator SA20-75, SA20-100, SA20-150 and SA20-200's, for all lengths from 600mm to 2400mm.

The Static Insertion Loss, Generated Noise Level and Pressure Loss were tested in accordance with BS 4718:1971 "Methods of Test for Silencers for Air Distribution Systems". The standard lays down the methodology for taking measurements and calculating the values from those measurements and states the tolerances on the accuracy of the testing procedure.

The tables attached contain the relevant values taken from our laboratory test measurements and calculations/extrapolations and are adjusted in the normal fashion (eg. limiting the published Insertion Loss performance to 50 dB etc.)

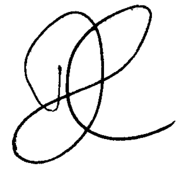
The data for the catalogue (Appendix A) is attached.

If you have any questions please contact us.

Yours sincerely,

**Jack Dalziel**
Consultant
For and on behalf of
Sound Research Laboratories Ltd

Checked by,



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SAFID سافيد

## Appendix A

### SA20-75 Attenuators

| Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|
| 0.6 | 9 | 13 | 22 | 36 | 45 | 39 | 33 | 29 |
| 0.9 | 10 | 16 | 27 | 41 | 49 | 47 | 38 | 33 |
| 1.2 | 11 | 18 | 31 | 46 | 50 | 50 | 43 | 38 |
| 1.5 | 12 | 21 | 36 | 50 | 50 | 50 | 48 | 42 |
| 1.8 | 13 | 24 | 41 | 50 | 50 | 50 | 50 | 46 |
| 2.1 | 14 | 26 | 45 | 50 | 50 | 50 | 50 | 50 |
| 2.4 | 15 | 29 | 50 | 50 | 50 | 50 | 50 | 50 |

### SA20-100 Attenuators

| Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|
| 0.6 | 7 | 10 | 18 | 34 | 46 | 40 | 33 | 29 |
| 0.9 | 8 | 12 | 22 | 37 | 50 | 46 | 36 | 31 |
| 1.2 | 9 | 14 | 26 | 40 | 50 | 50 | 39 | 33 |
| 1.5 | 9 | 17 | 30 | 44 | 50 | 50 | 41 | 35 |
| 1.8 | 10 | 19 | 34 | 47 | 50 | 50 | 44 | 37 |
| 2.1 | 11 | 21 | 38 | 50 | 50 | 50 | 47 | 39 |
| 2.4 | 11 | 24 | 42 | 50 | 50 | 50 | 49 | 41 |

### SA20-150 Attenuators

| Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|
| 0.6 | 8 | 12 | 17 | 34 | 44 | 28 | 23 | 22 |
| 0.9 | 8 | 14 | 20 | 37 | 47 | 32 | 26 | 24 |
| 1.2 | 9 | 15 | 23 | 40 | 50 | 36 | 29 | 26 |
| 1.5 | 10 | 17 | 26 | 43 | 53 | 40 | 32 | 28 |
| 1.8 | 11 | 18 | 29 | 46 | 57 | 44 | 35 | 31 |
| 2.1 | 11 | 20 | 32 | 49 | 40 | 48 | 38 | 33 |
| 2.4 | 12 | 21 | 35 | 50 | 50 | 50 | 41 | 35 |

### SA20-200 Attenuators

| Length (mm) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
|---|---|---|---|---|---|---|---|---|
| 0.6 | 7 | 11 | 16 | 25 | 27 | 23 | 21 | 20 |
| 0.9 | 8 | 12 | 18 | 30 | 33 | 26 | 23 | 21 |
| 1.2 | 8 | 14 | 21 | 35 | 39 | 30 | 25 | 23 |
| 1.5 | 9 | 15 | 23 | 40 | 44 | 33 | 28 | 24 |
| 1.8 | 9 | 17 | 26 | 45 | 50 | 37 | 30 | 26 |
| 2.1 | 10 | 18 | 28 | 50 | 50 | 40 | 32 | 27 |
| 2.4 | 11 | 19 | 30 | 50 | 50 | 43 | 34 | 28 |

**Dave Clarke**
Associate Director
For and on behalf of Sound Research Laboratories Ltd

**Trevor Hickman**
Executive Consultant

*Sound Research Laboratories Ltd* *C/01/5L/0121/L12A/JTD/mth* *6 December 2001* *Page 2 of 2*
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