Noise Control in HVAC

Active Passive or None

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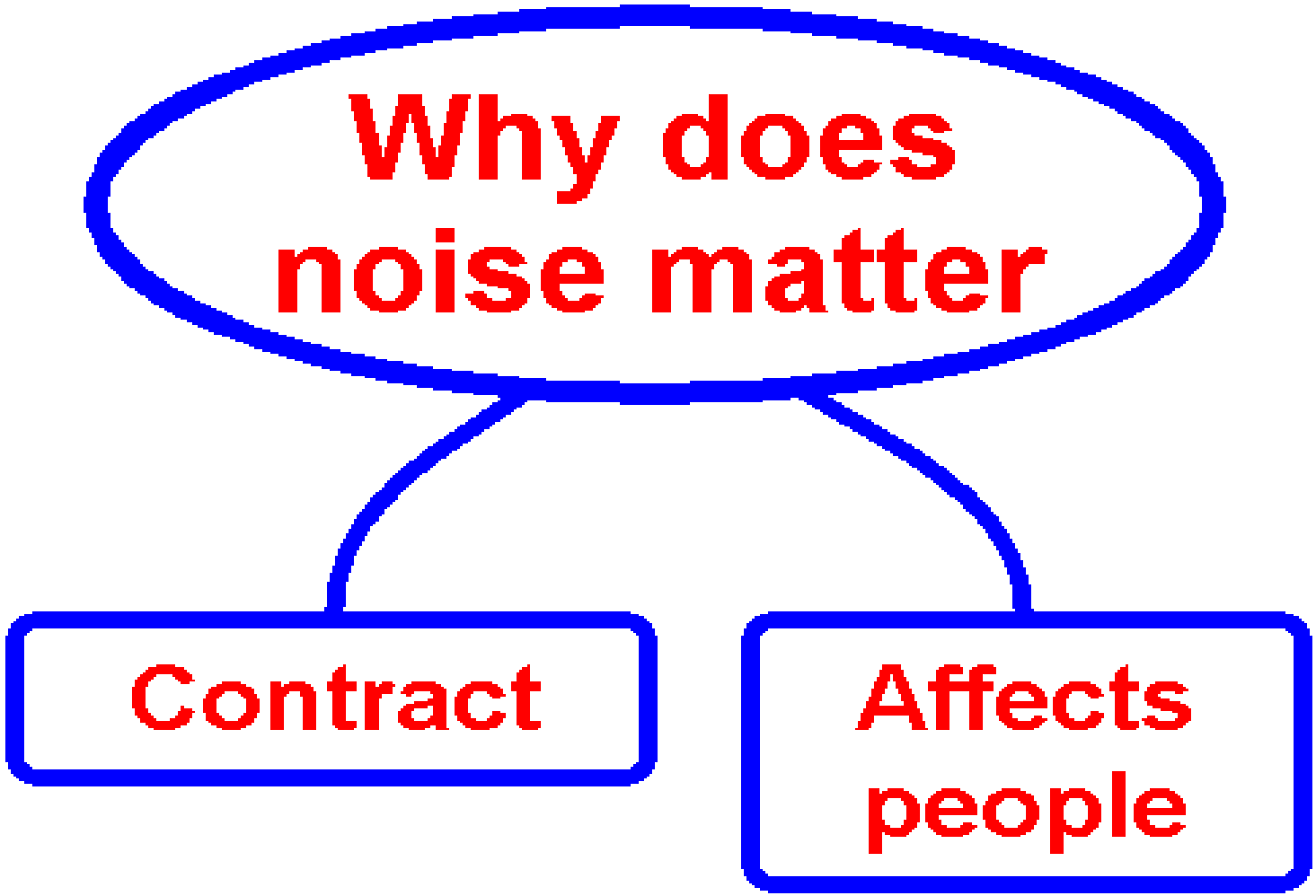
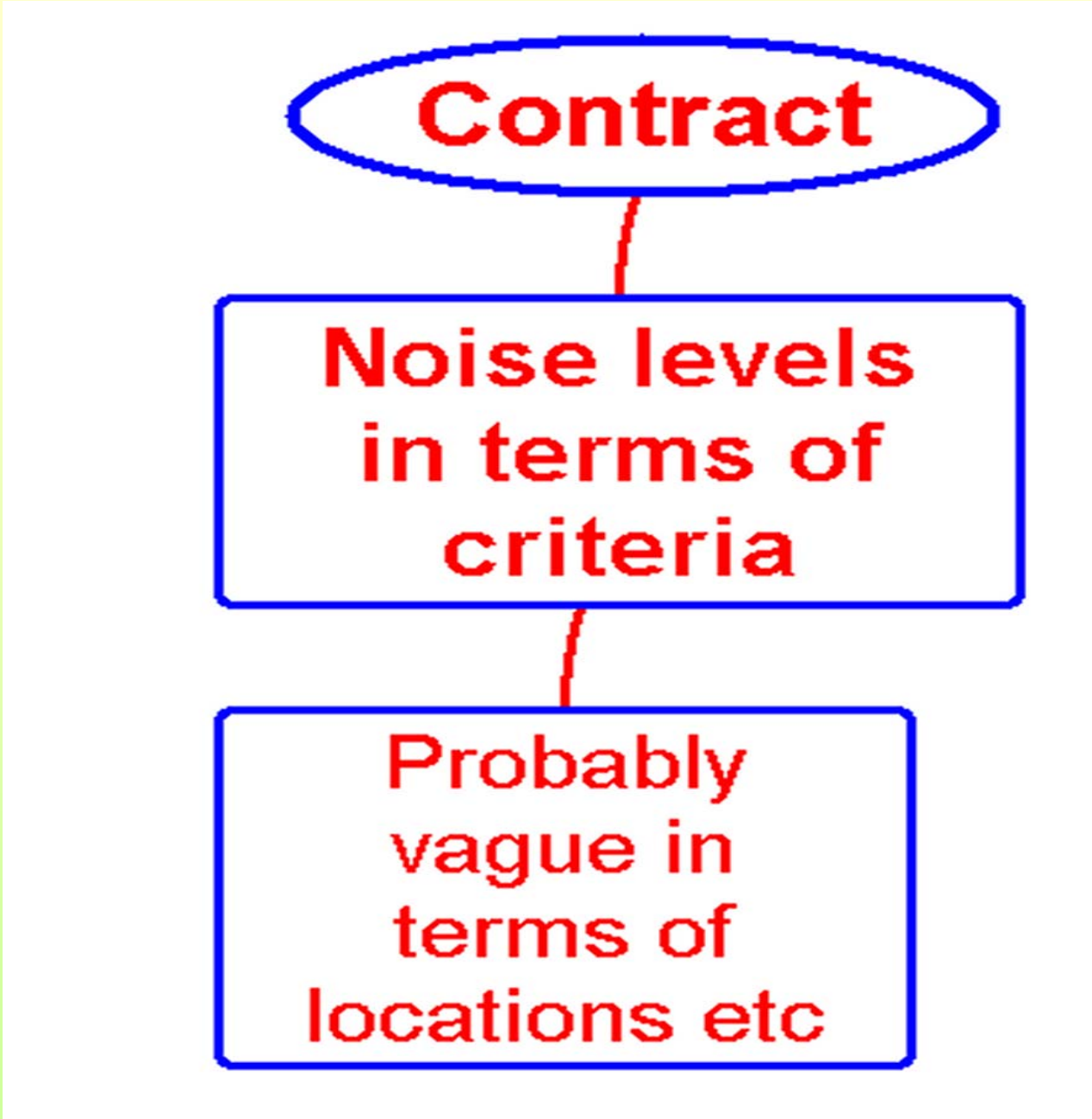
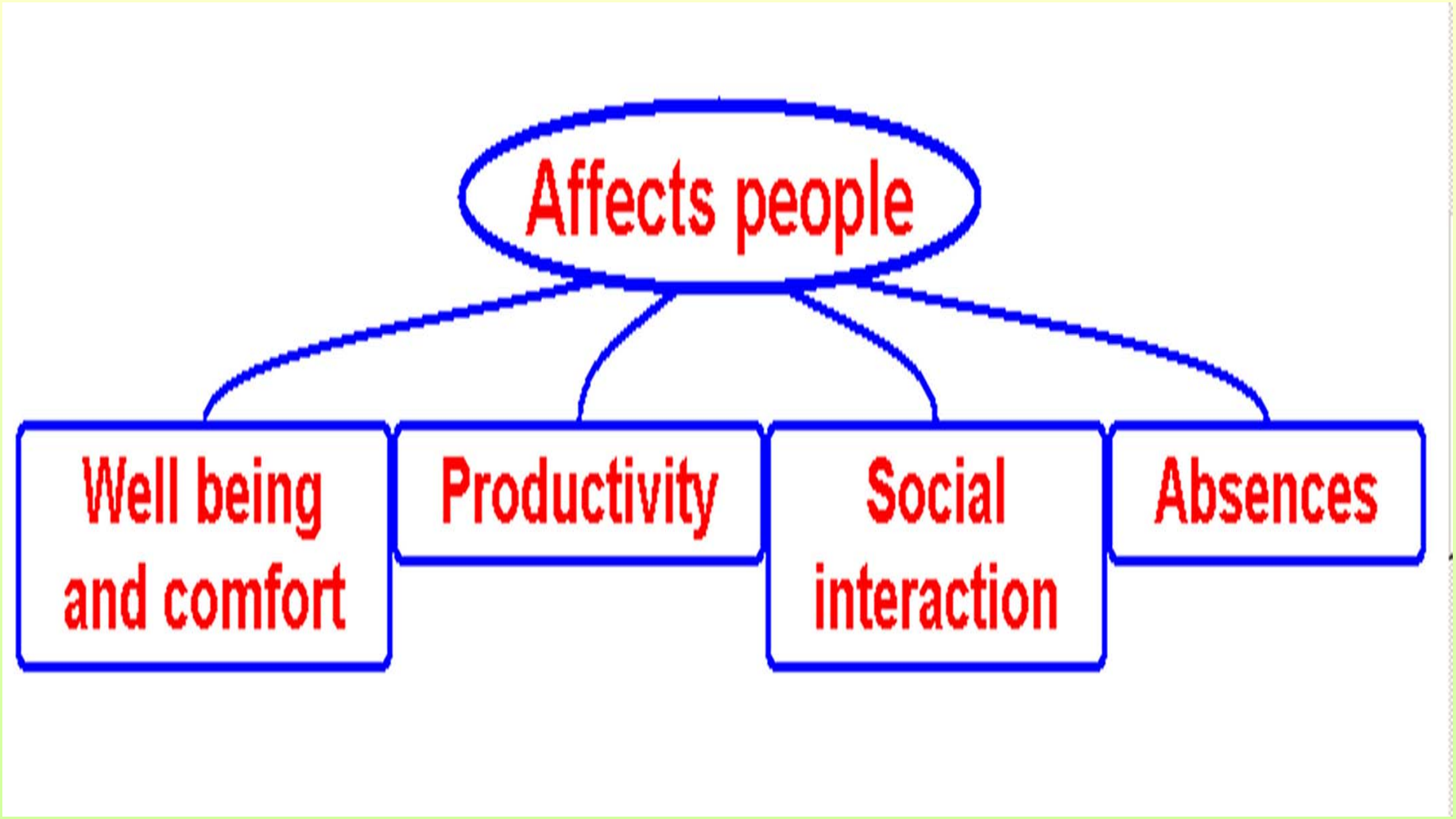
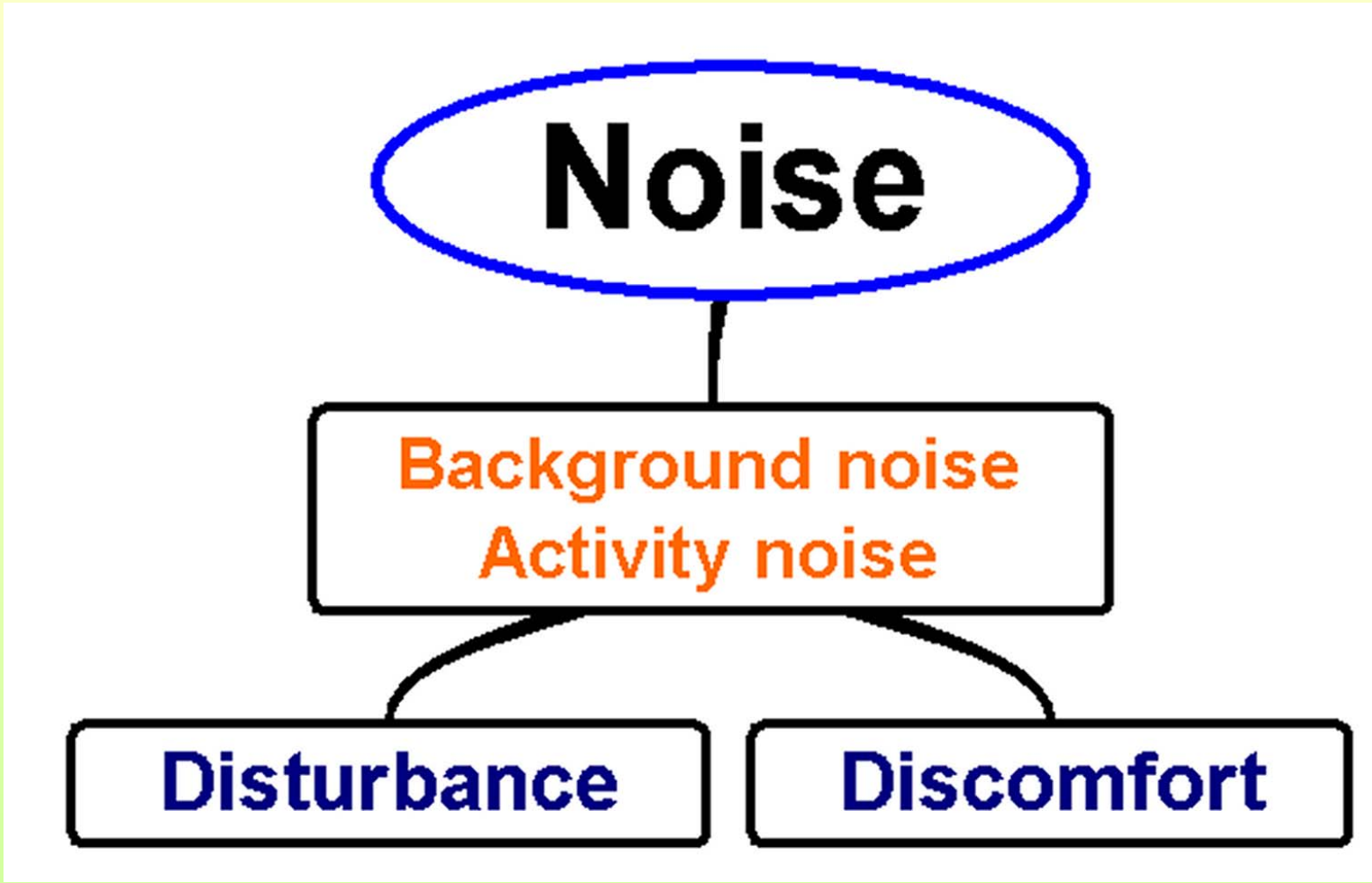

Why does noise matter
Contract
Affects people

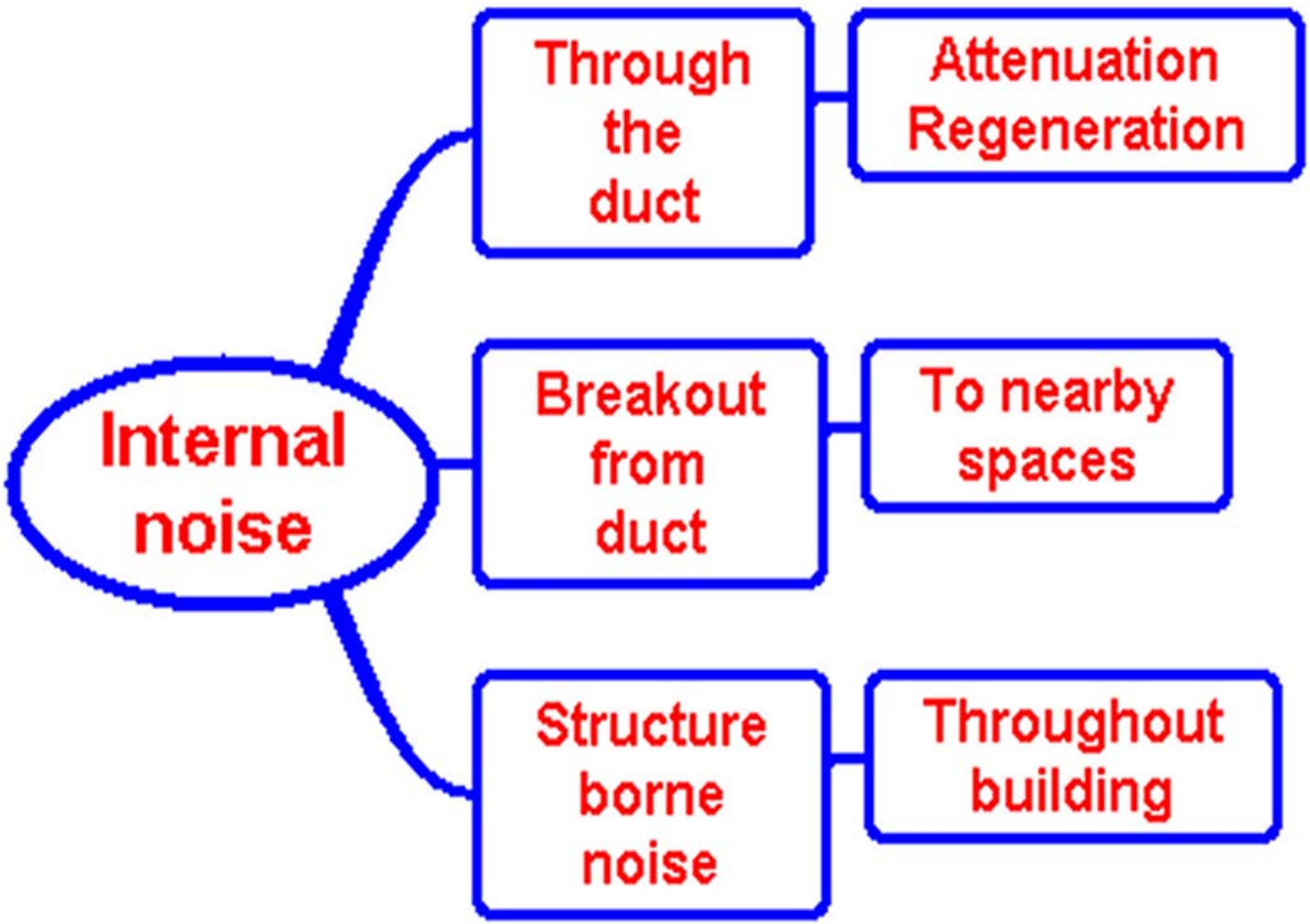

Contract
Noise levels in terms of criteria
Probably vague in terms of locations etc


Affects people
Well being and comfort
Productivity
Social interaction
Absences

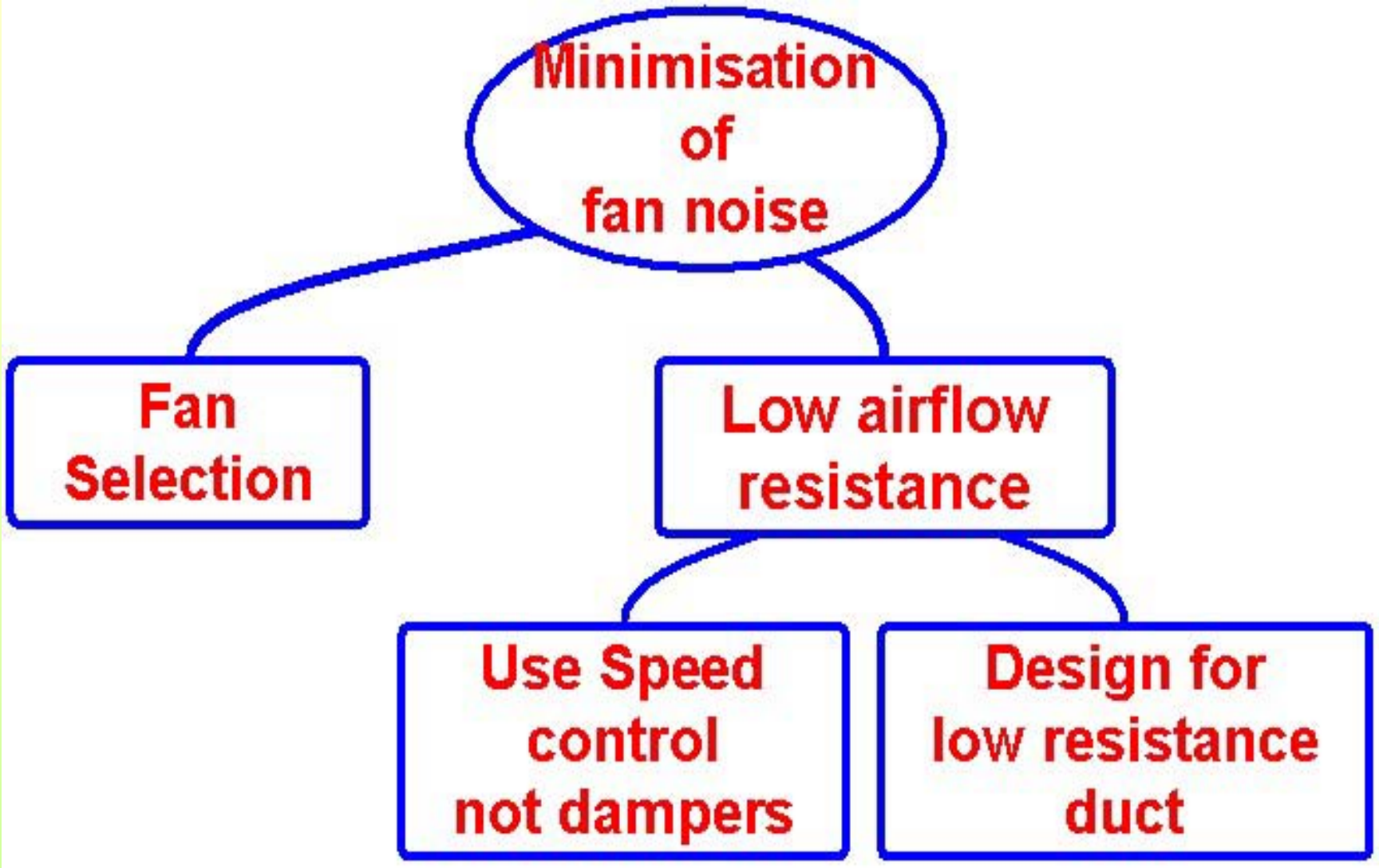

Noise
Background noise
Activity noise
Disturbance
Discomfort

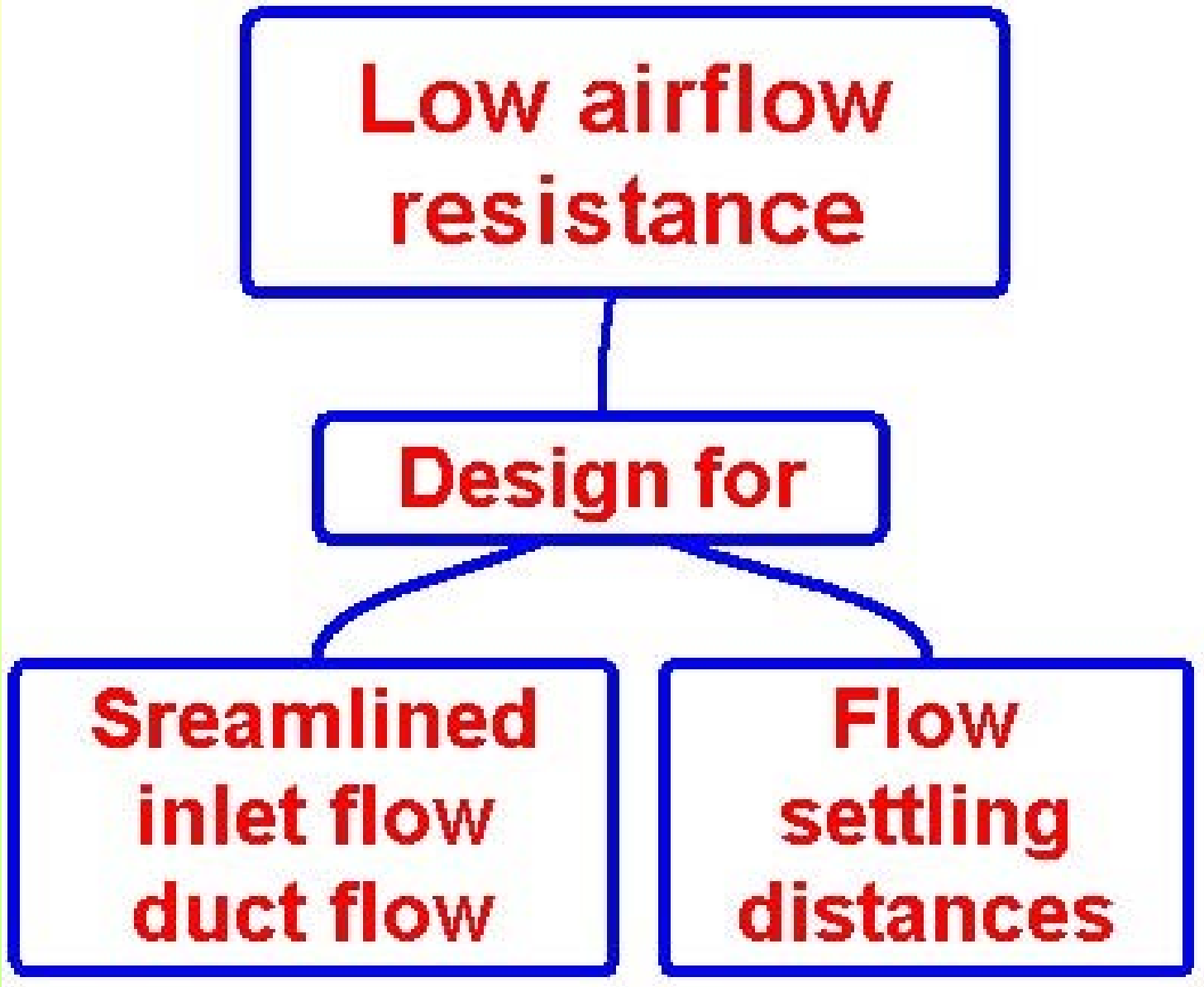
Noise Sources in HVAC - B5

3	Noise sources in building services	
→	3.1	Fans
→	3.2	Variable air volume (VAV) systems
→	3.3	Grilles and diffusers
	3.4	Roof-top units
→	3.5	Fan coil units
	3.6	Chillers, compressors and condensers
	3.7	Pumps
	3.8	Stand-by generators
	3.9	Boilers
	3.10	Cooling towers
	3.11	Lifts
	3.12	Escalators



Fan Noise Propagation


Minimisation of fan noise
Fan Selection
Low airflow resistance
Use Speed control not dampers
Design for low resistance duct

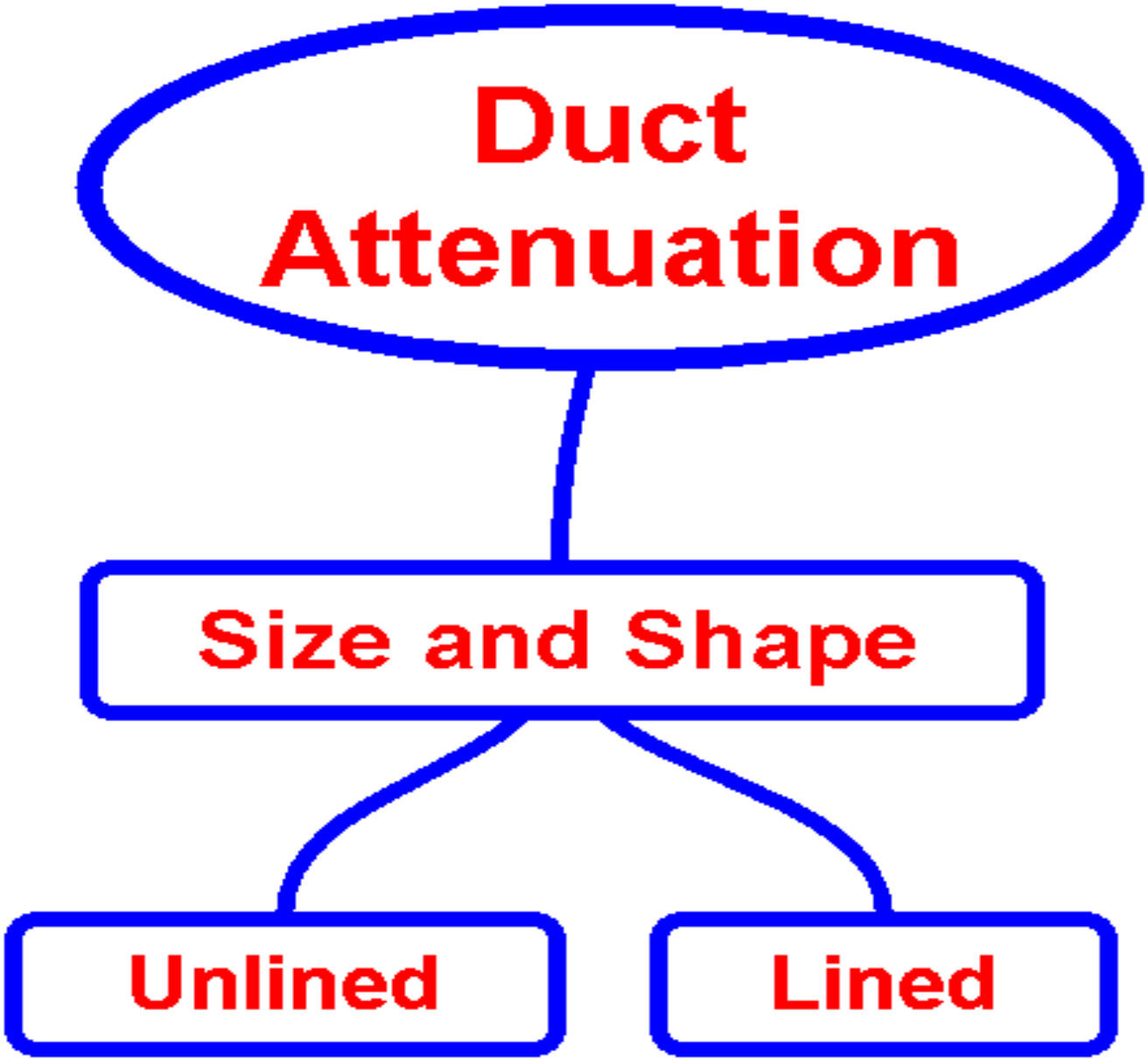

Low airflow resistance
Design for
Sreamlined inlet flow duct flow
Flow settling distances

Control

of

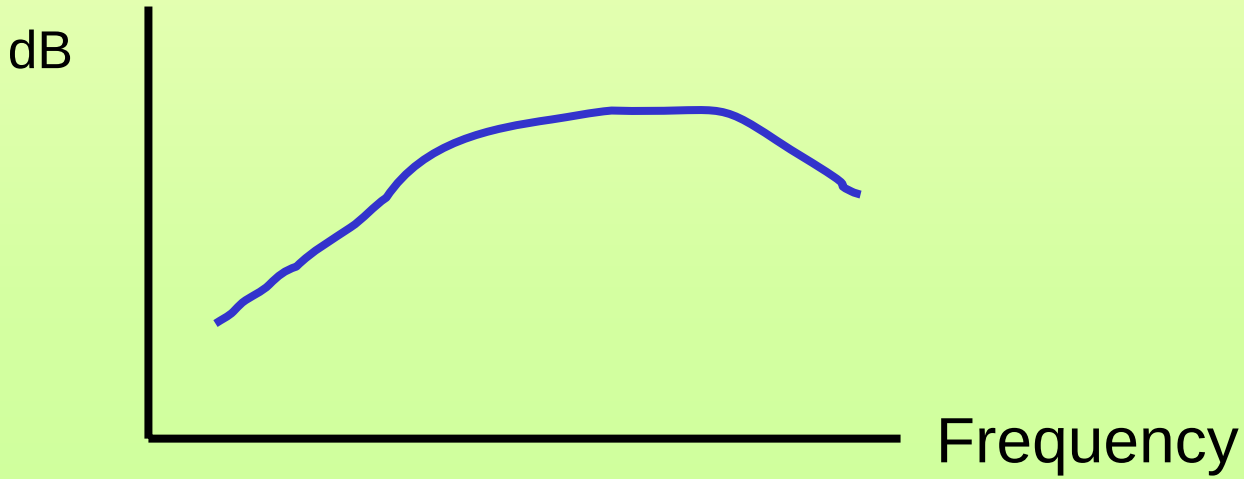
Noise Transmission in Ducts

Attenuation of Travelling Noise


Duct Attenuation
Size and Shape
Unlined
Lined

All duct systems have

Frequency dependent attenuation



Lined Ducts used widely in the USA.

Gives noise attenuation and thermal insulation, but raises concerns for health. Not now recommended for sensitive locations except with special precautions. Older systems taken out, for example in schools and health care.

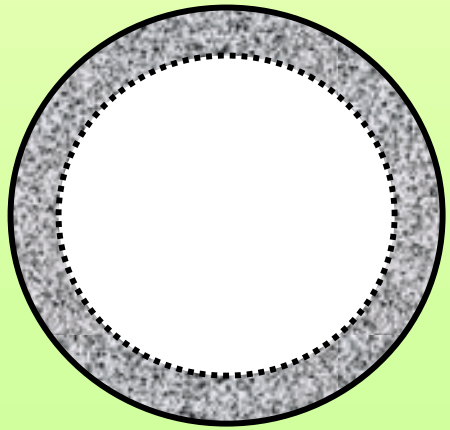
UK uses more localised silencers than USA. UK ~100%. USA ~50%

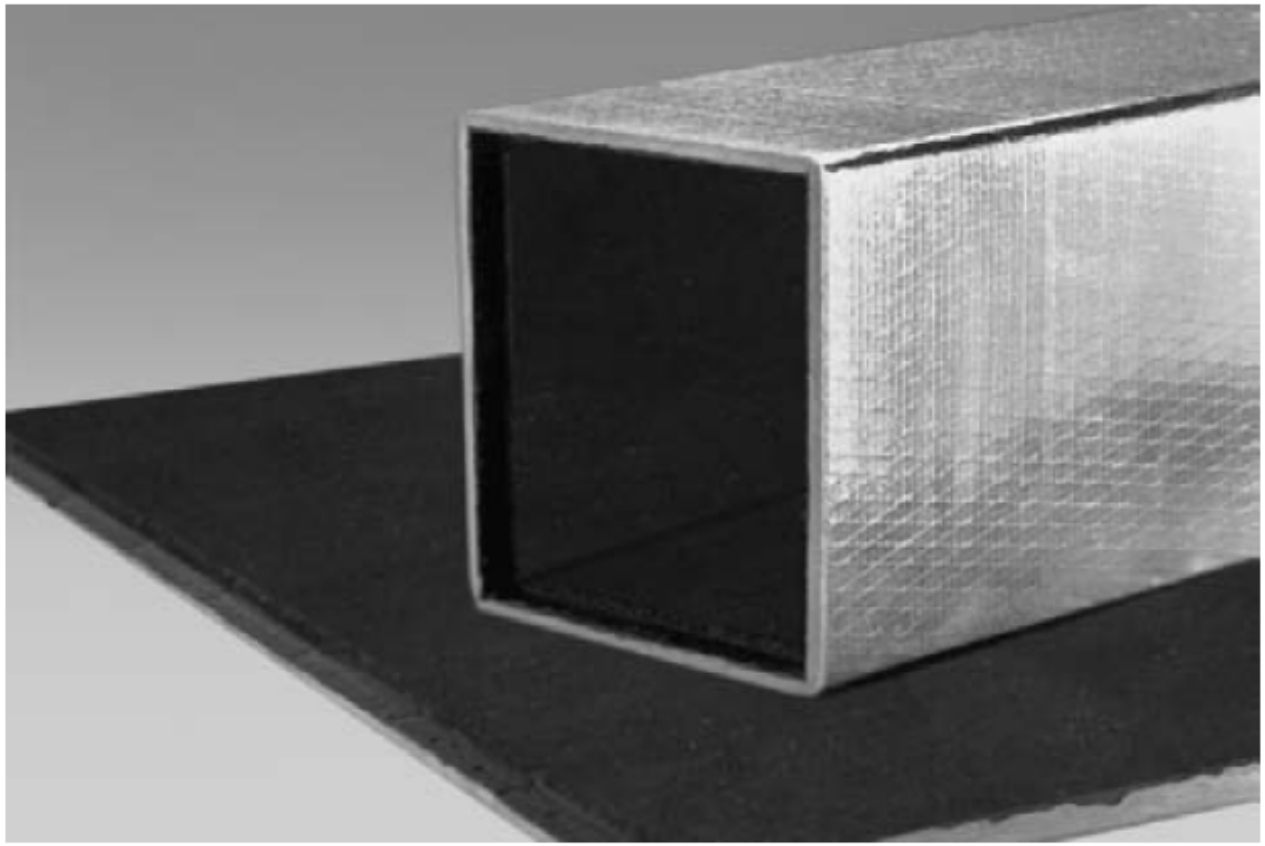
Lined Duct

Rectangular duct attenuation depends on

Perimeter/area, (P_d/A_d), and Lining Thickness

Attenuation is not as well known for circular ducts





Operating Temperature Limit: 250°F (121°C)

Johns Manville Superduct RC Air Duct Board

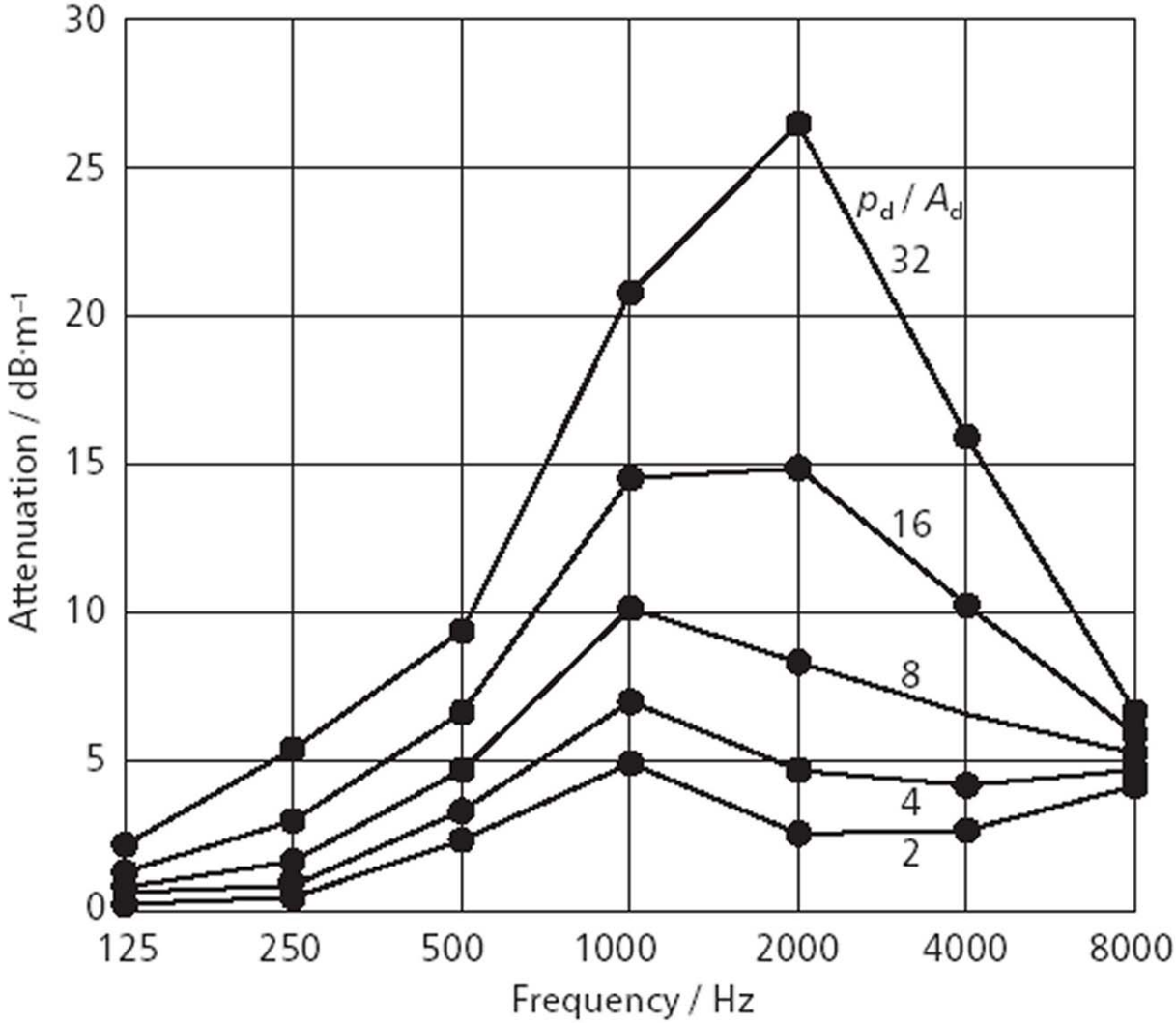


Figure 6.1 Attenuation of lined duct; 25 mm lining **[From CIBSE B5]**

Significance of P_d/A_d

Duct Dimensions	P_d/A_d
3m x 3m	1.3
1m x 1m	4
1.2m x 0.3m	8
0.3m x 0.3m	13
0.15m x 0.15m	27

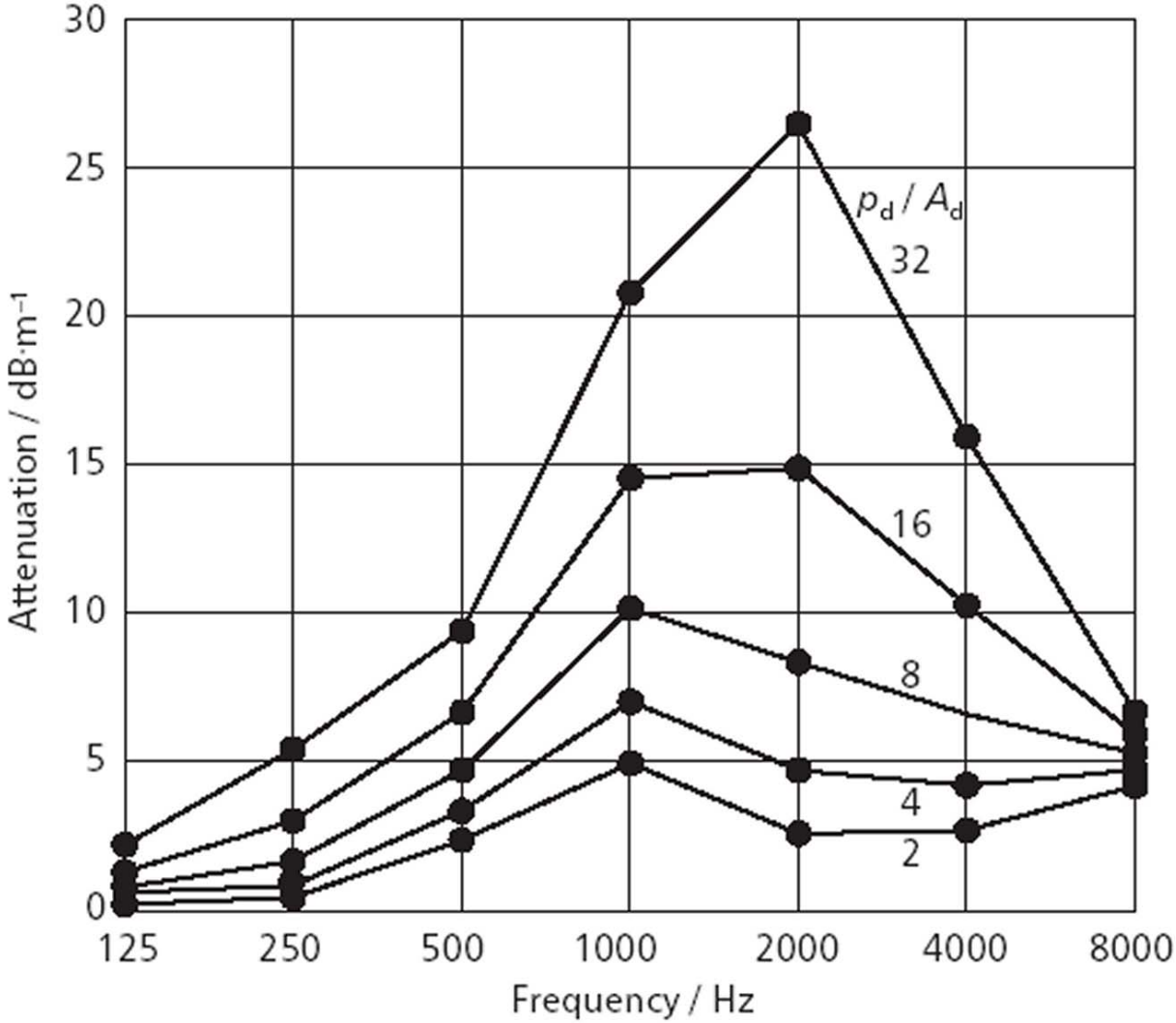
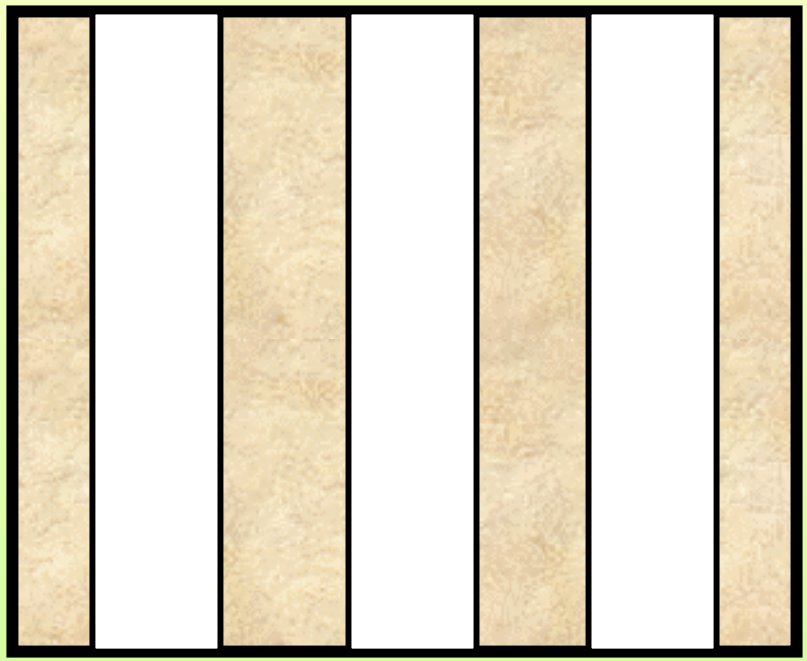
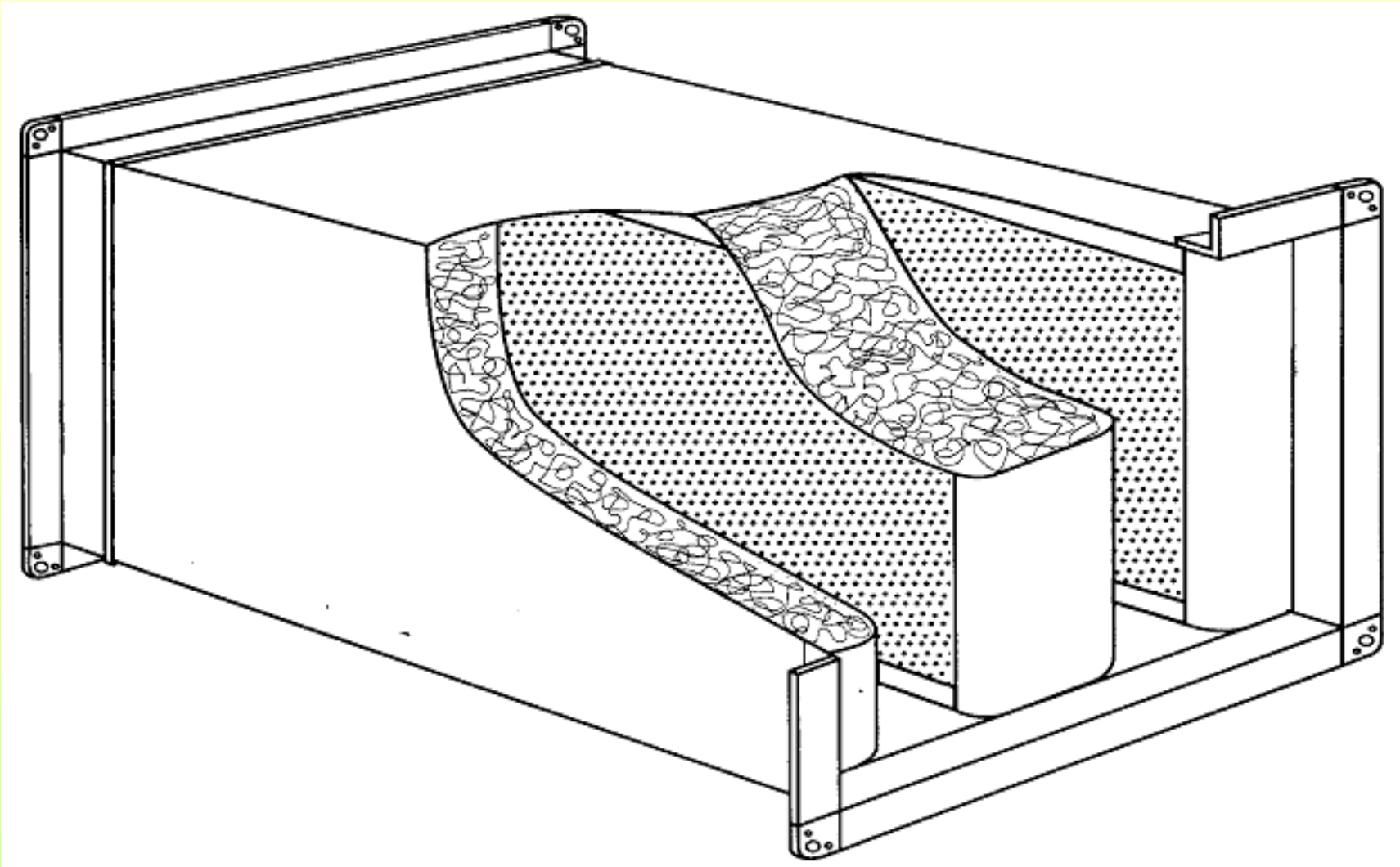


Figure 6.1 Attenuation of lined duct; 25 mm lining

Localised Attenuation

Parallel baffle (passive) silencer





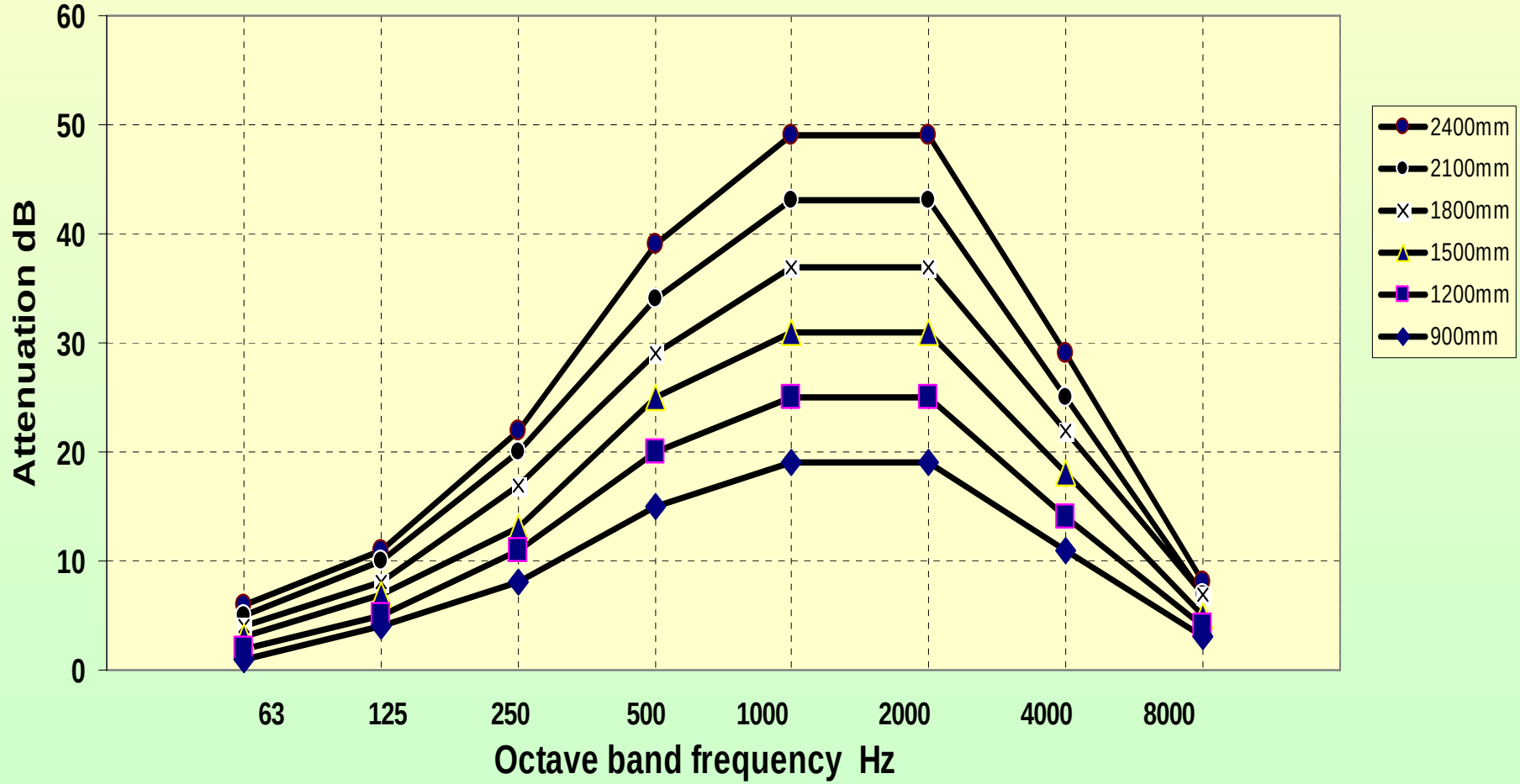
Parallel Baffle Silencer

Duct Silencers - parallel baffle

Considerations

- Length, width, height….. weight
- Baffle thickness, Air gap
- Air velocity
- Pressure loss - varies as $(\text{velocity})^2$
- Location wrt fan, bends etc

Silencer attenuation 200mm/200mm
Variation with length



Limitations of Passive Silencers

- Poor low frequency attenuation
- LF attenuation improved by narrow air gaps and longer length
- This leads to higher pressure loss

Energy loss in silencers

Power (W) used against pressure loss

$$= \frac{\text{Air flow } (m^3/s) \times \text{pressure loss(Pa)}}{\text{fan-motor efficiency}}$$

$10 m^3/s$ into 100Pa > 1KW

Energy use by fans in the UK

(Lockwood - FETA Magazine December 2005)

Fans in the range 1.1kW to 400kW consume

33.5TWh per year of electricity

Potential saving of

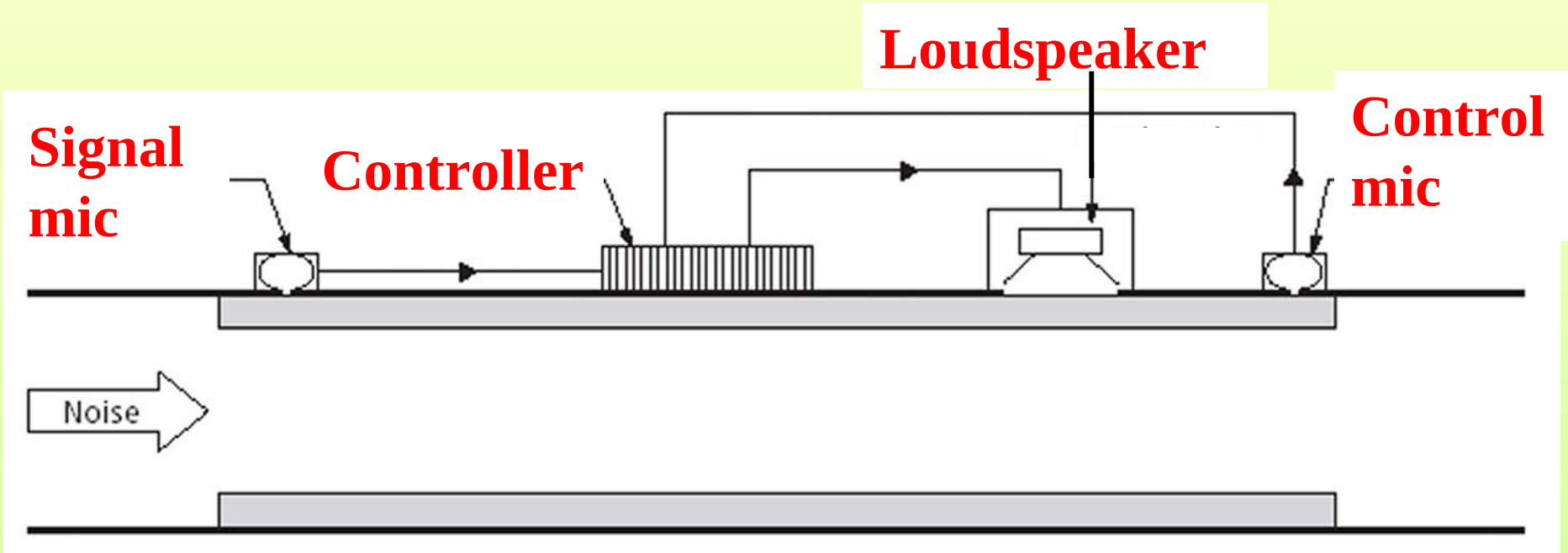
22.5% (7.5TWh)

by improved fan and system efficiency.

Sector Electricity Use – UK 2003

Sector	Use TWh
Industry	113.926
Transport	8.528
Domestic	115.761
Public Admin	20.966
Commercial	74.328
Agriculture	4.025

Total 337.444 TWh

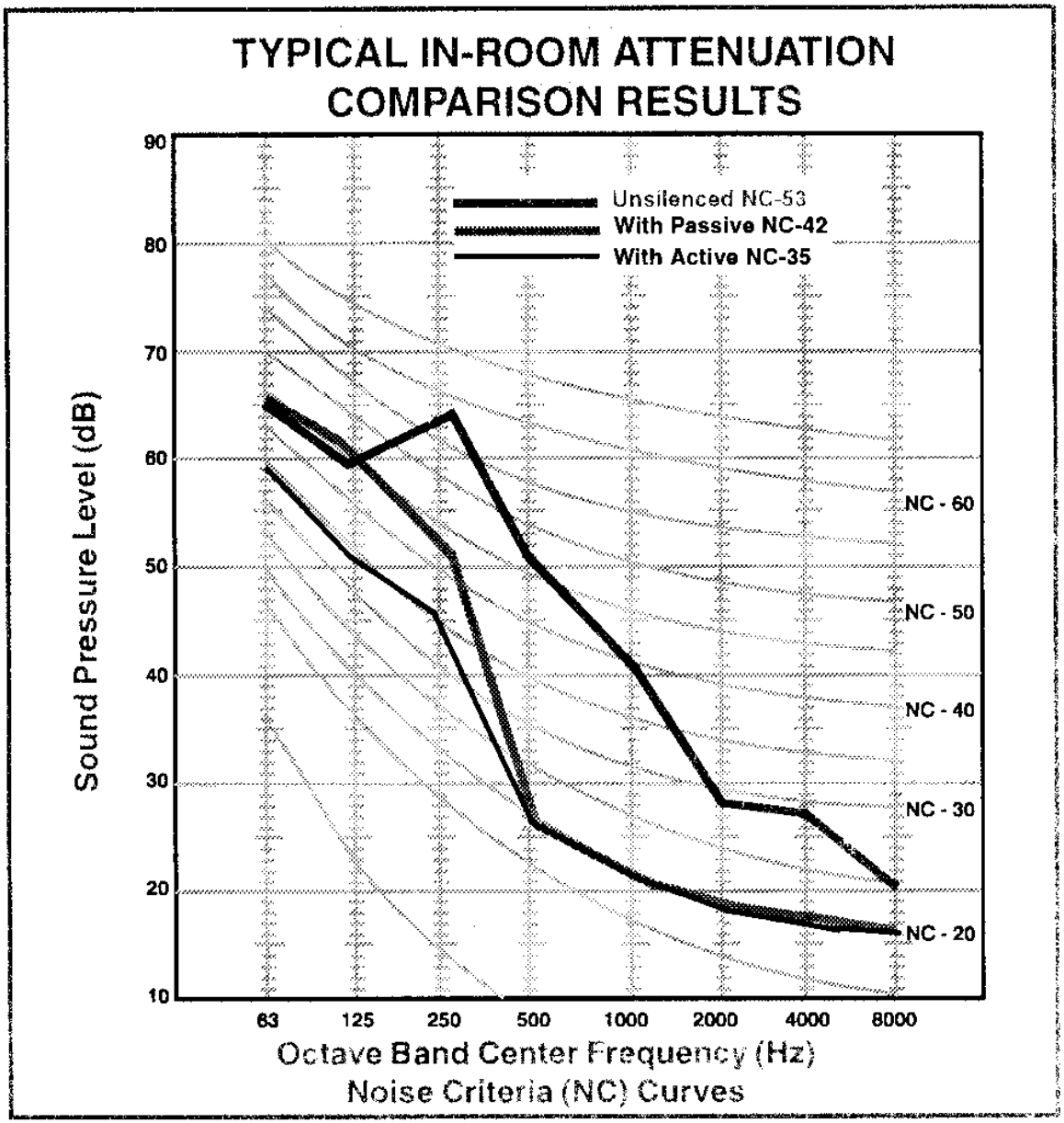


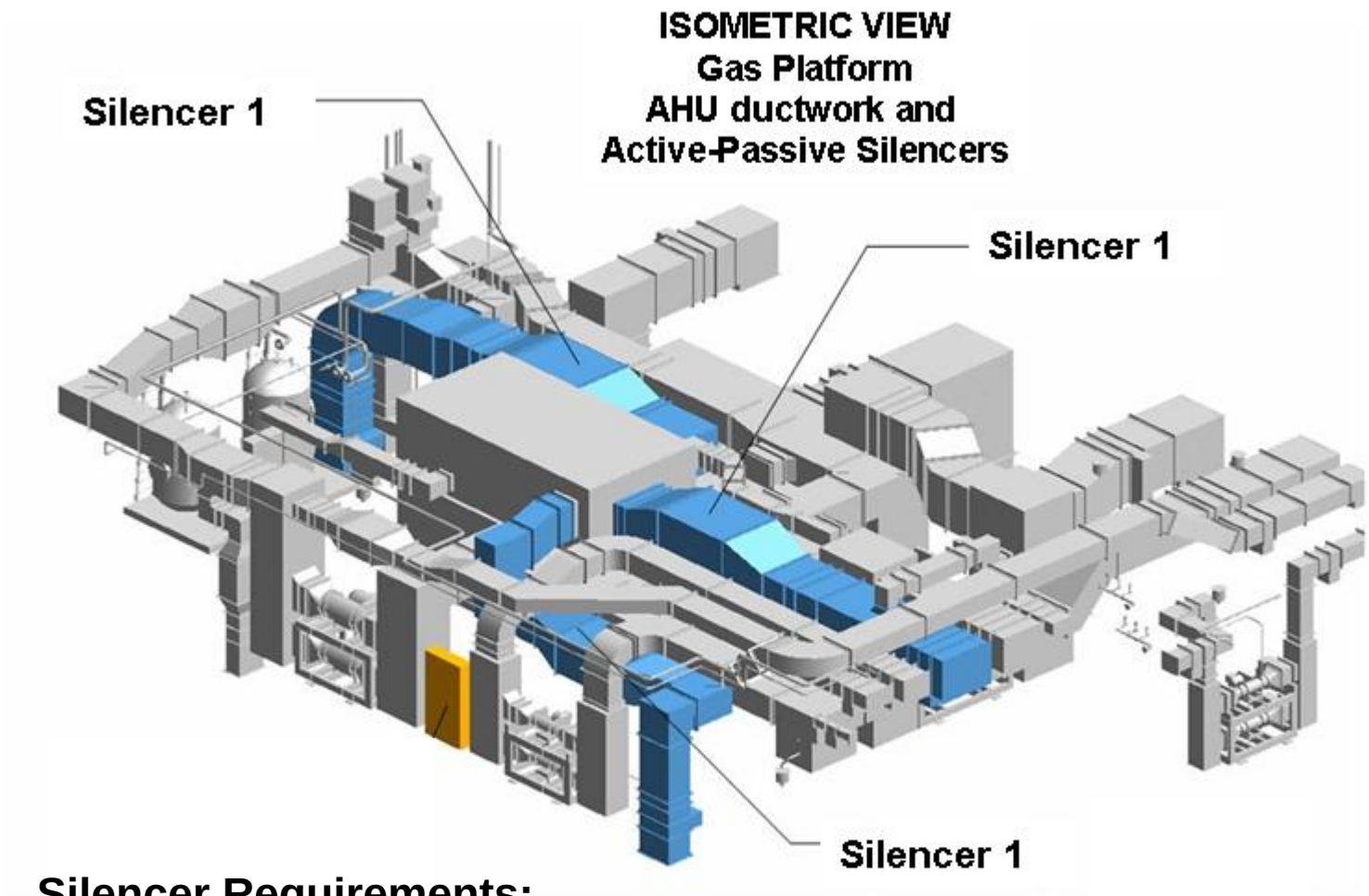
Active silencer

Active silencers

- Good low frequency attenuation
- Normally combine active/passive for full range attenuation
- Lower pressure loss
- Smaller size and weight than passive for similar LF performance
- Higher initial cost?

Active Silencer attenuation





Silencer Requirements:

1.5 m length;

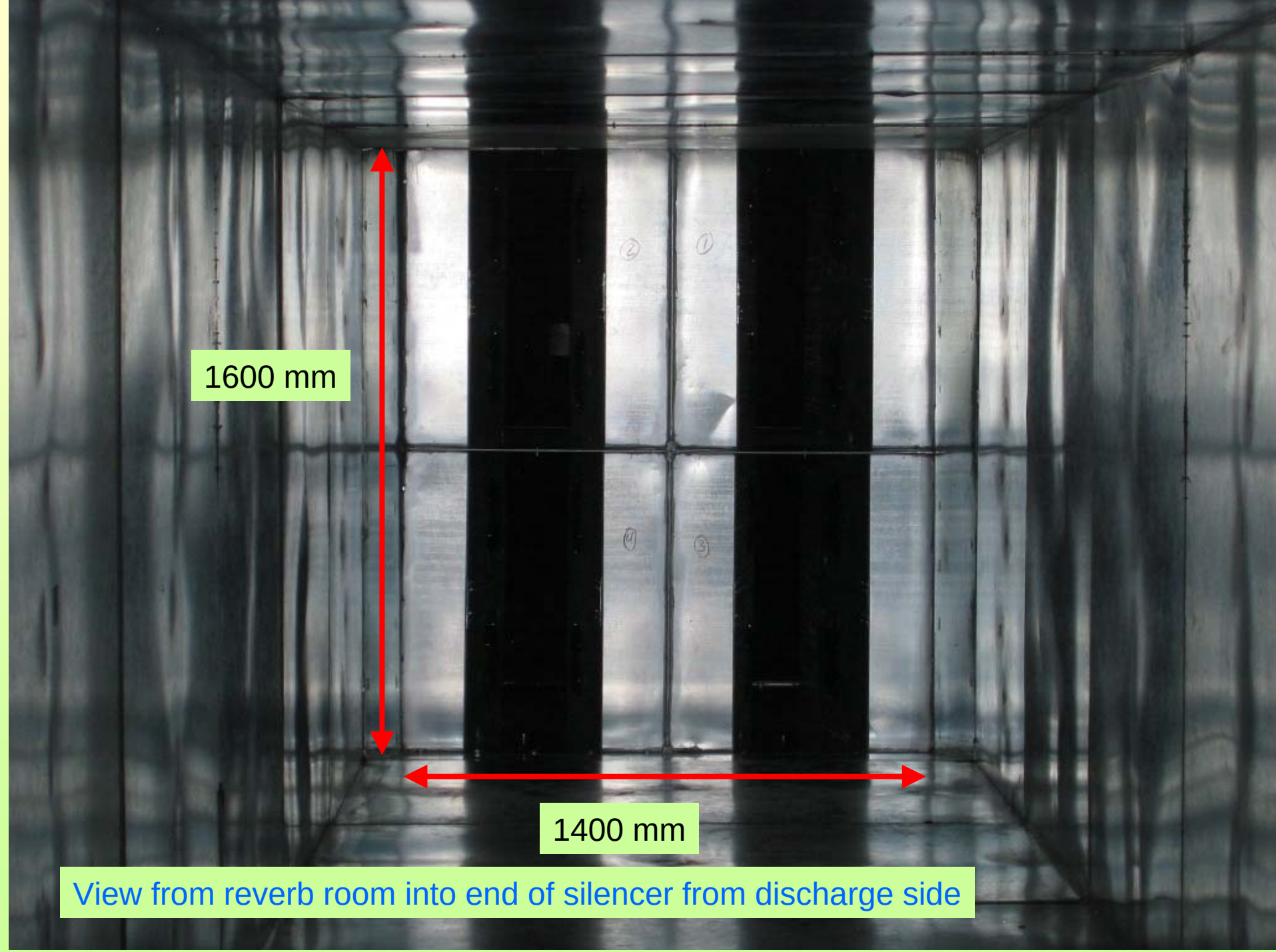
<50 Pa pressure loss;

>25 dB attenuation at 125 Hz

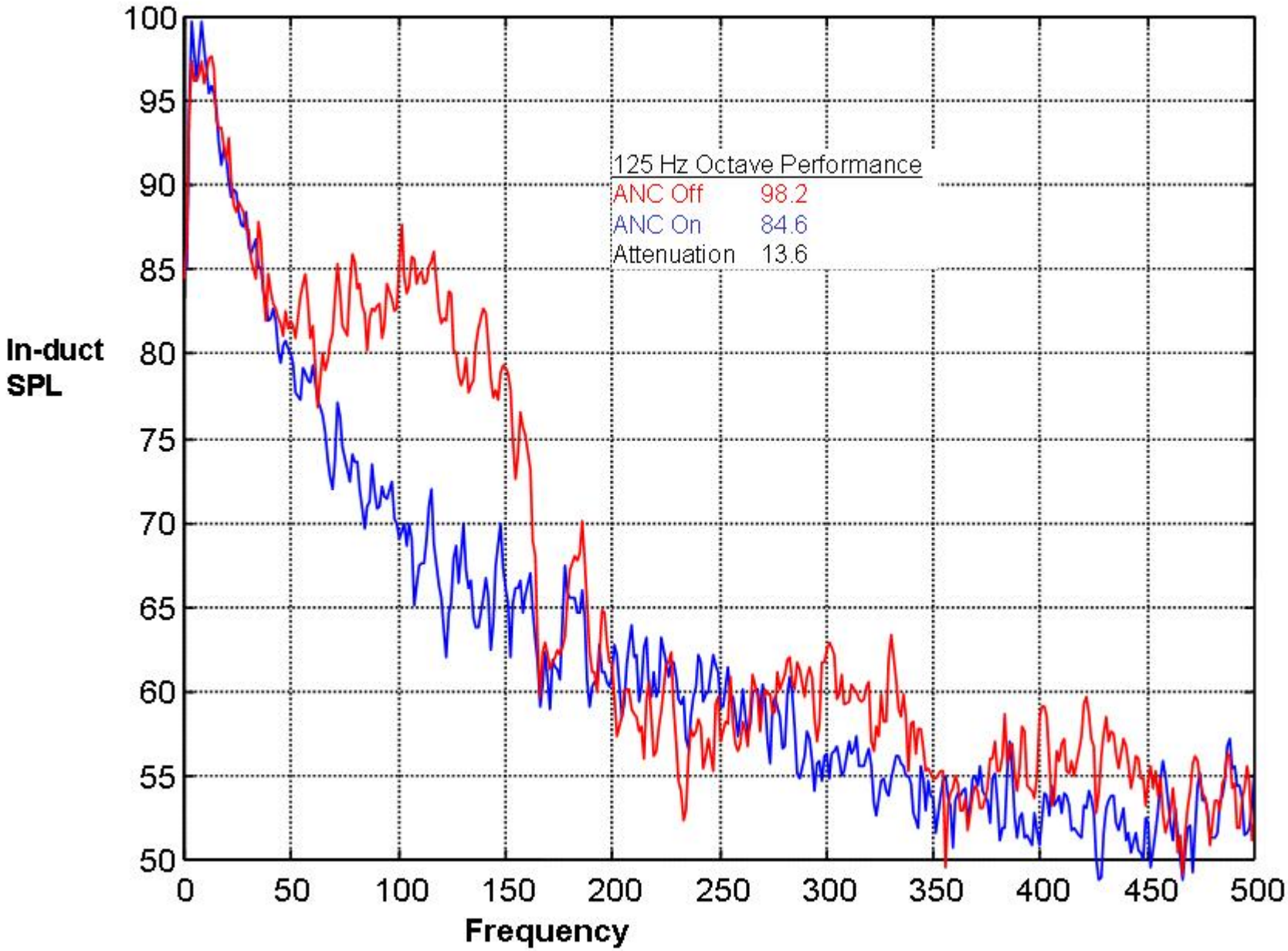
Non-porous media

← Not possible by passive silencer

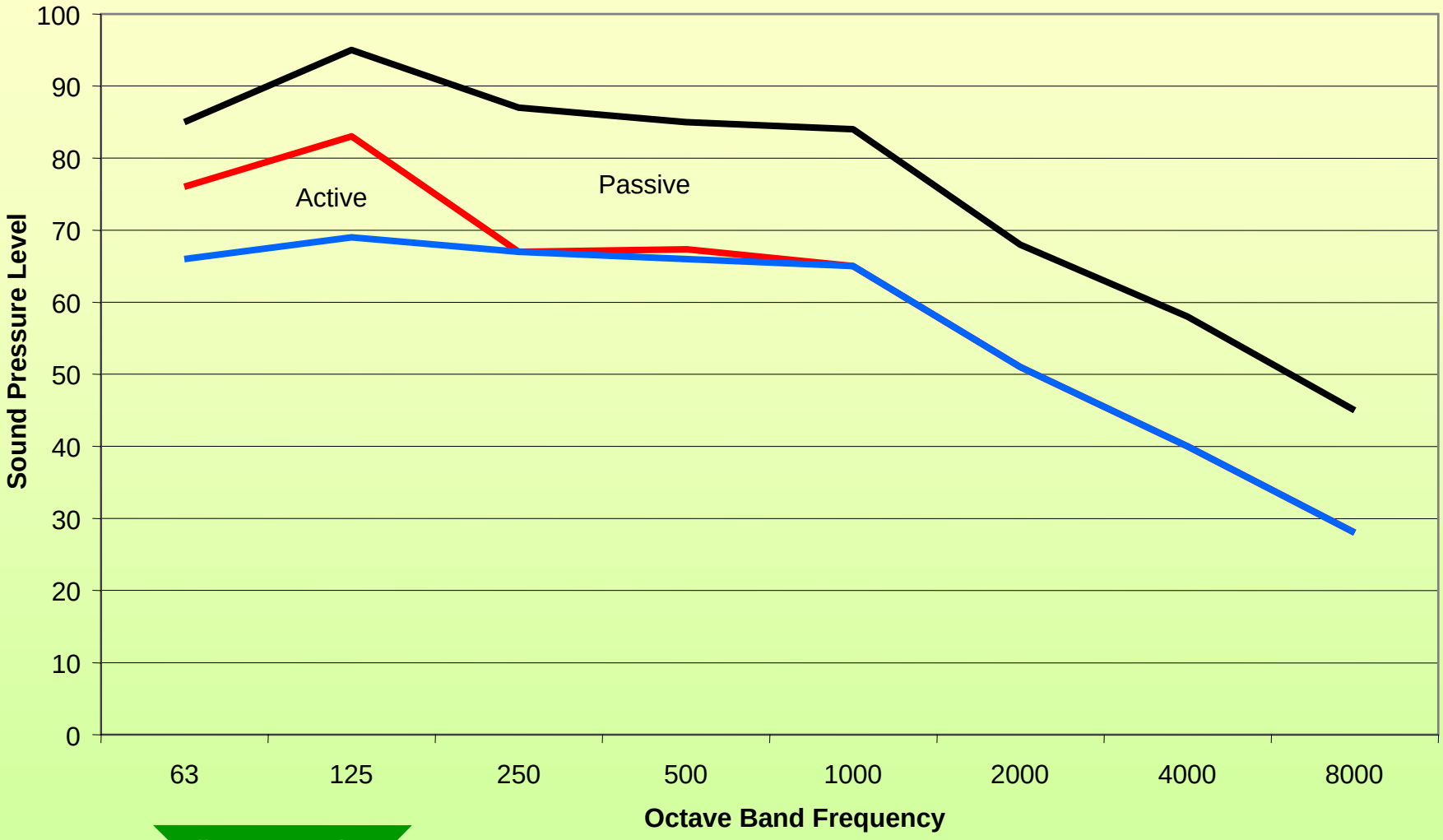

Silencer Dimensions:
1500 L x 1400 W x 1600 H



View from reverb room into end of silencer from discharge side


125 Hz Octave Performance
ANC Off 98.2
ANC On 84.6
Attenuation 13.6
In-duct SPL
Frequency
100
95
90
85
80
75
70
65
60
55
50
0
50
100
150
200
250
300
350
400
450
500

Gas Platform AHU Active-Passive Silencer



Vibro-Acoustics

Wise Associates

Passive silencing √

Active silencing √

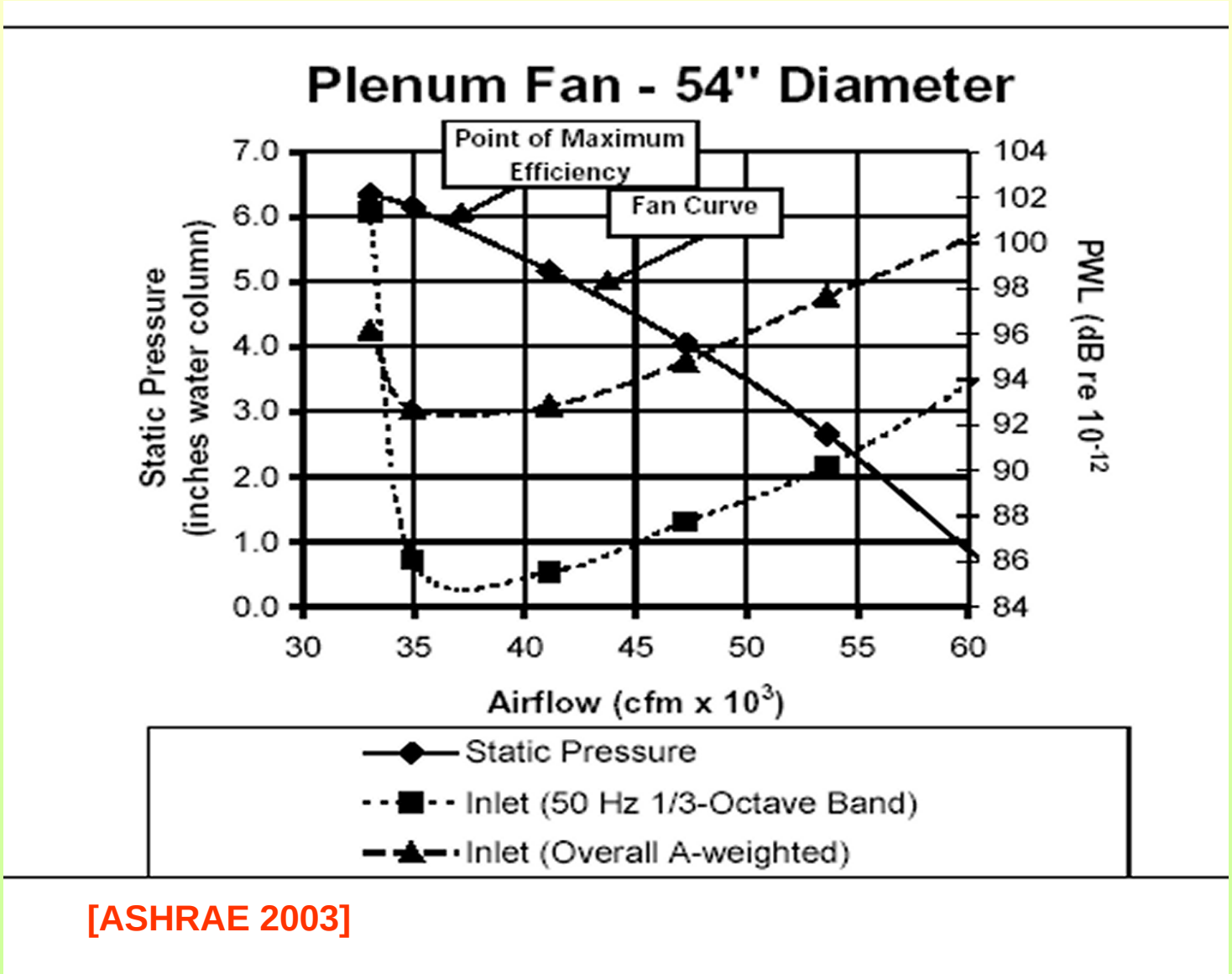
Is no silencing possible?

Is no silencing possible?

- Very quiet fan operating optimally
- Good duct design
- Modify our noise level requirements
  - less demanding criteria

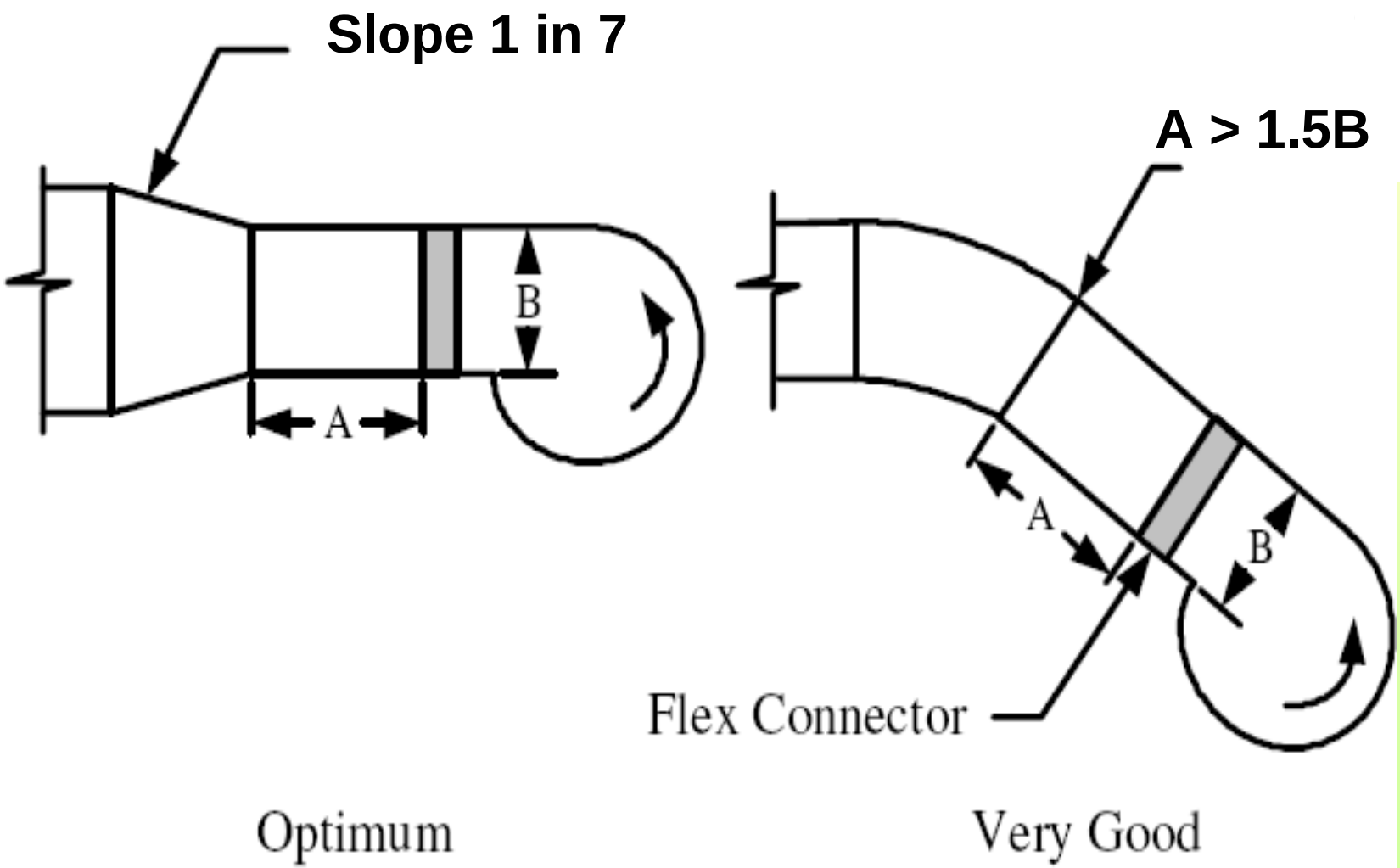
[One of the necessary lifestyle changes in the future?]

Fan is quietest at maximum efficiency



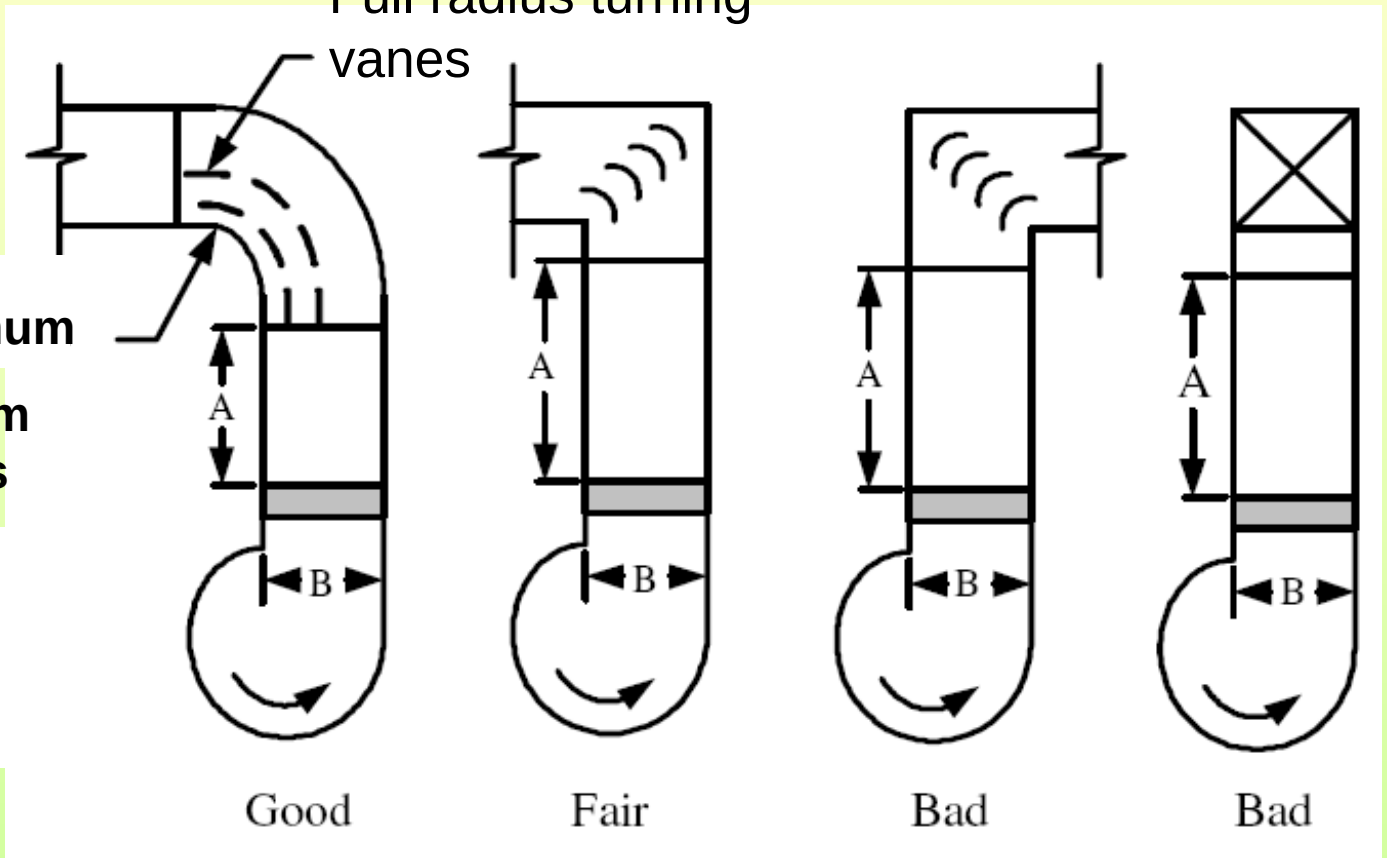
[ASHRAE 2003]

Fan outlet configuration - 1



From SMACNA Guide - **HVAC Sound and Vibration Manual 2005**

Fan outlet configuration - 2



From SMACNA Guide

Reducing air flow generated noise

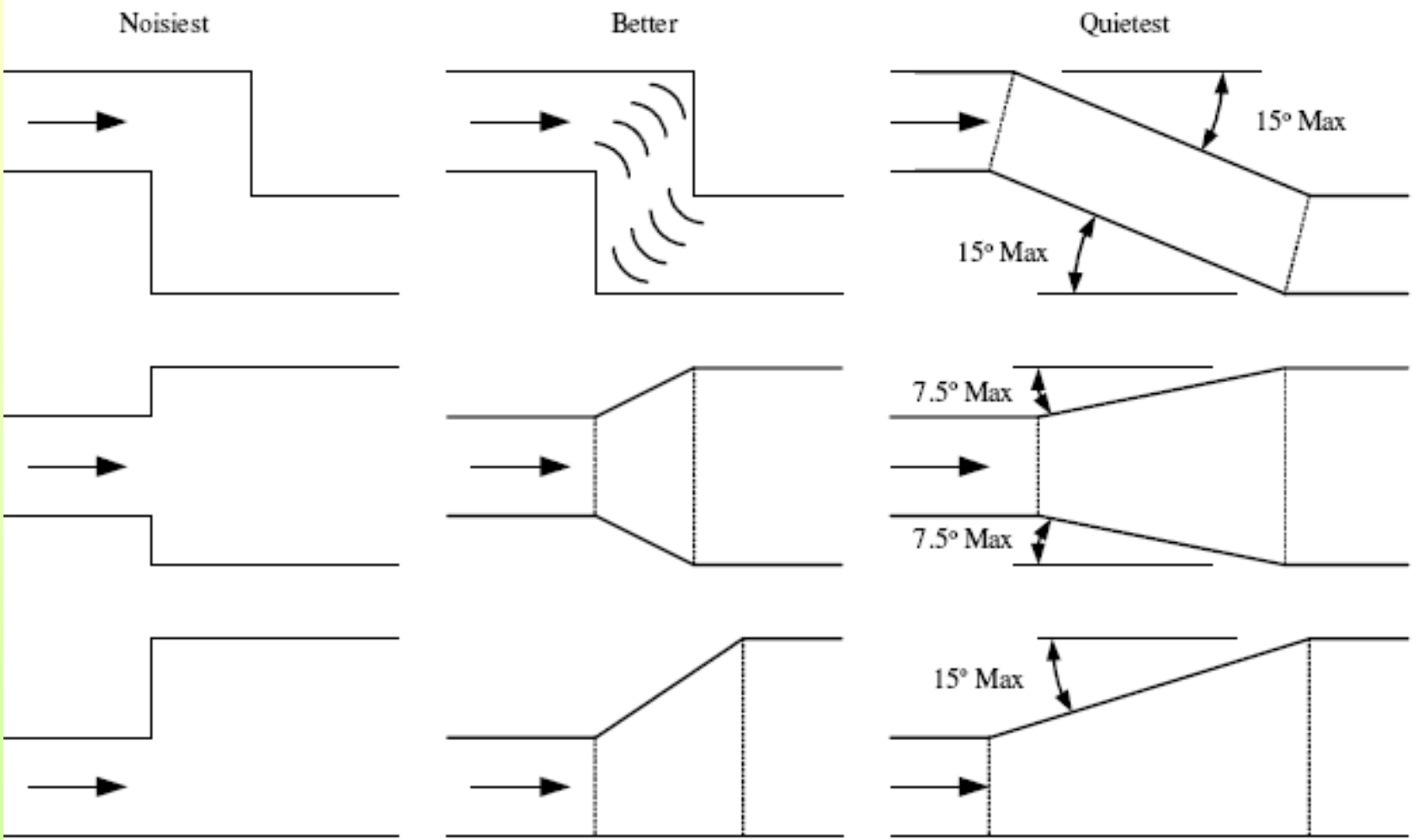


FIGURE 3-13 RECOMMENDATIONS FOR MINIMIZING AIRFLOW GENERATED NOISE IN DUCT TRANSITIONS AND OFFSETS

From SMACNA Guide

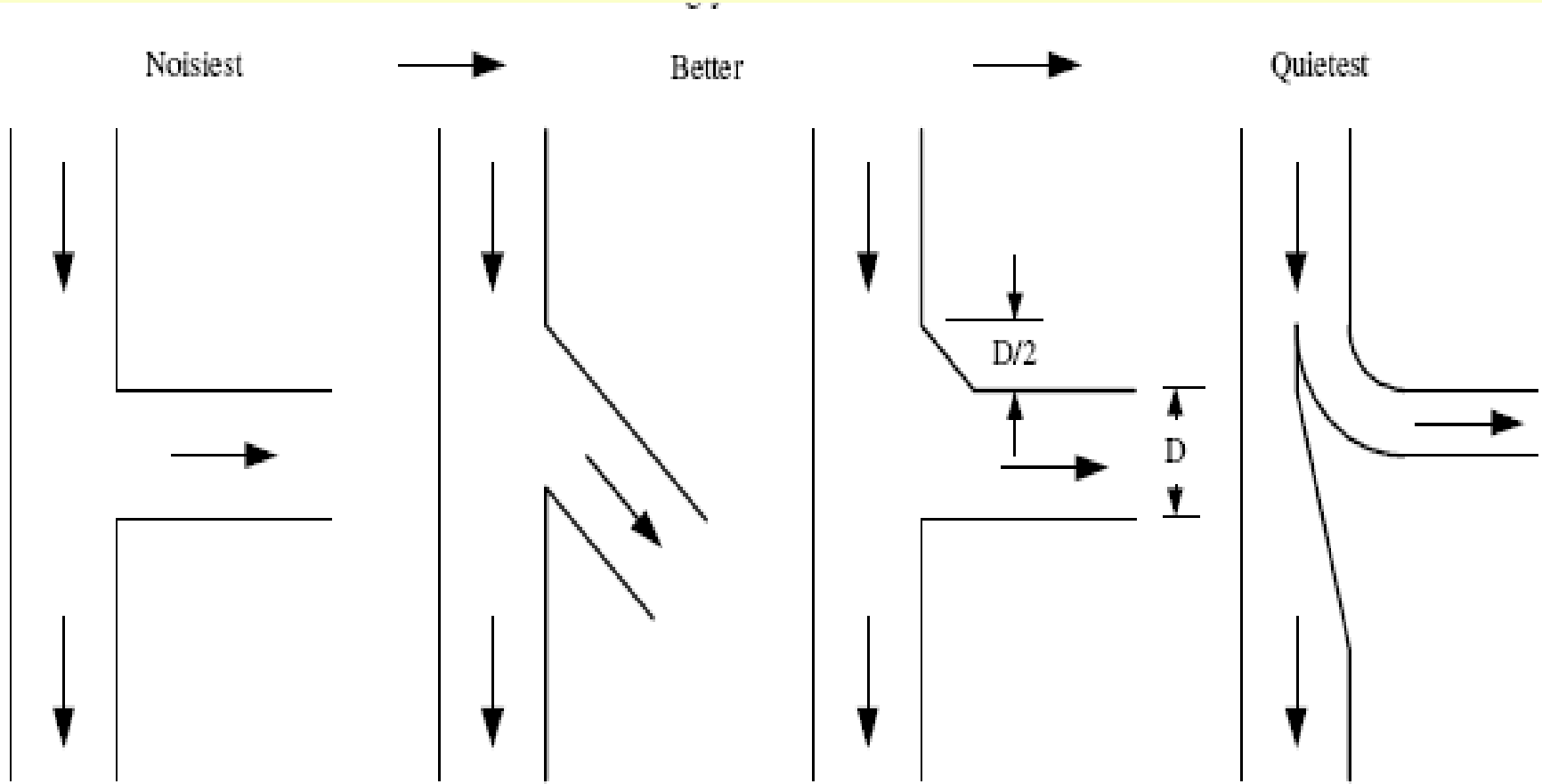


FIGURE 3-14 RECOMMENDATIONS FOR MINIMIZING AIRFLOW GENERATED NOISE IN DUCT BRANCH TAKEOFFS

From SMACNA Guide

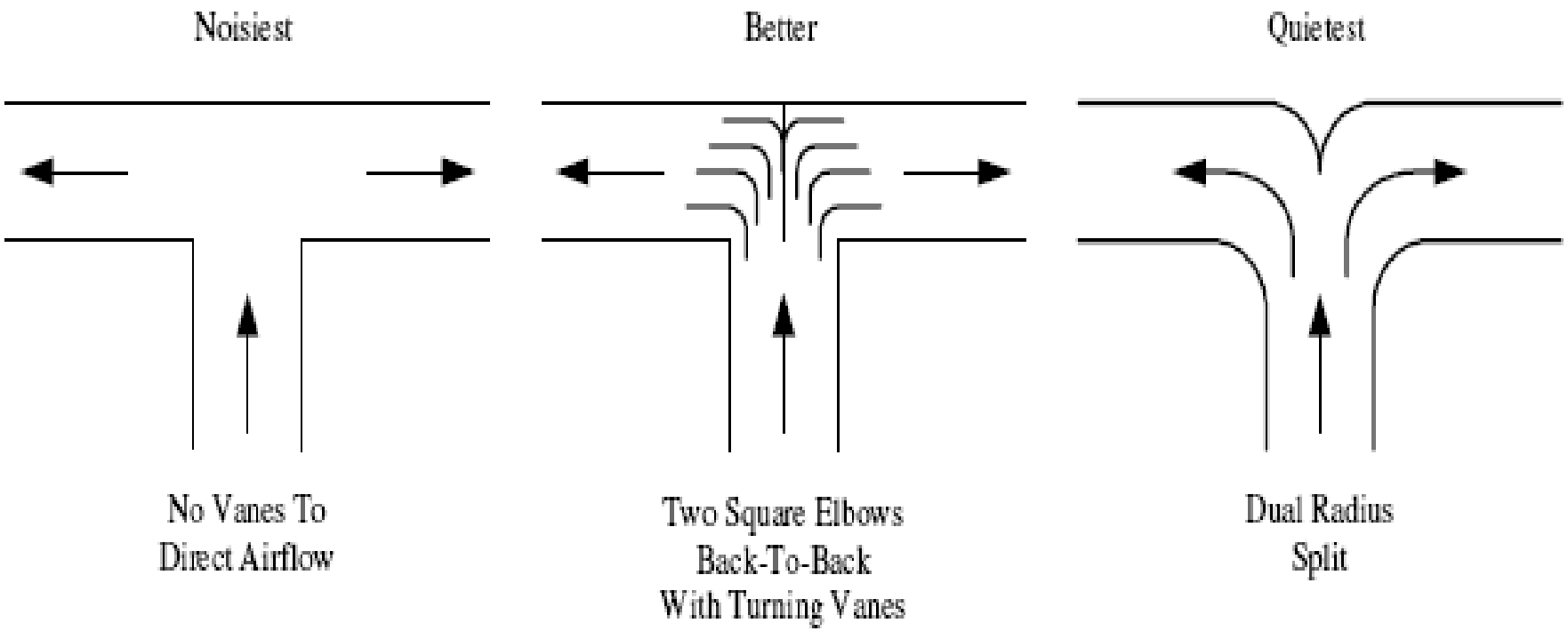


FIGURE 3-15 RECOMMENDATIONS FOR MINIMIZING AIRFLOW GENERATED NOISE IN DUCT TEES

From SMACNA Guide

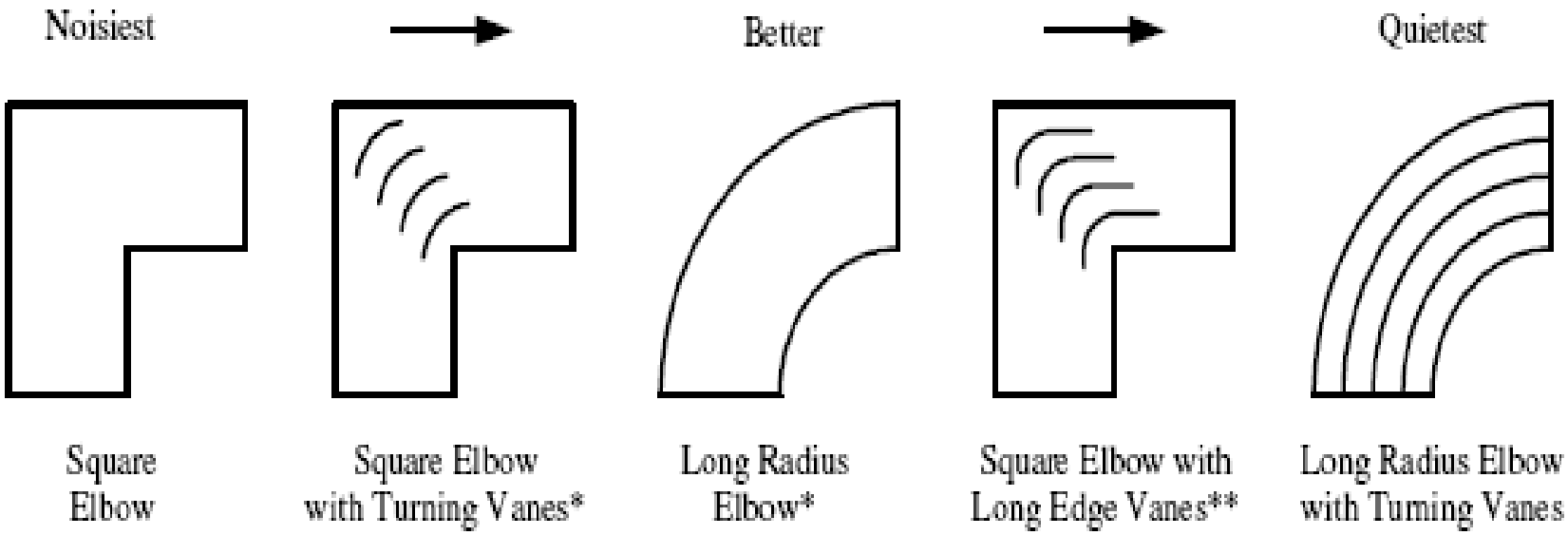
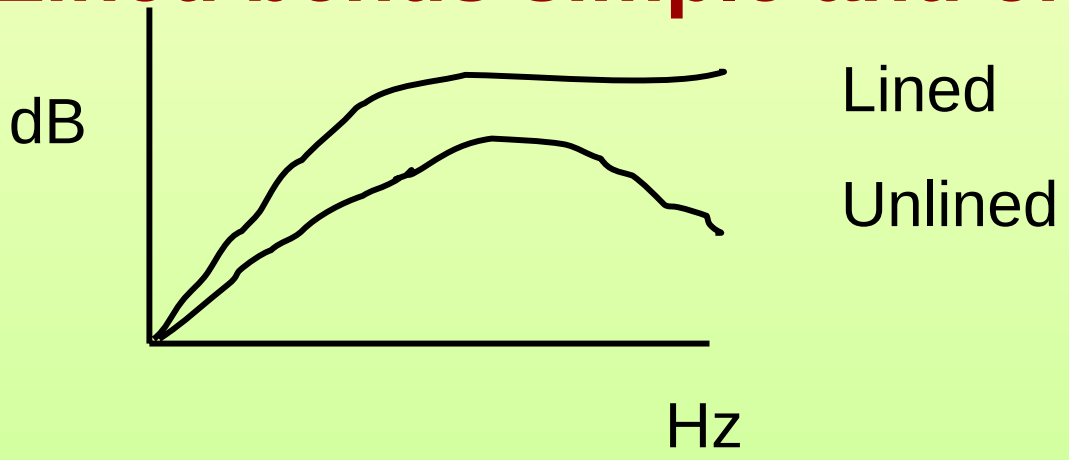


FIGURE 3-16 RECOMMENDATIONS FOR MINIMIZING AIRFLOW GENERATED NOISE IN DUCT ELBOWS

From SMACNA Guide

Most duct elements have attenuation which increases with frequency, although attenuation may drop at higher frequencies.

Lined bends simple and effective



Residual low frequency attenuation requirements obtained by active silencers

?

Do we over-silence?

How much are criteria conditioned by culture and expectations?