power levels, at a point in the ducting before and after the silencer is fitted.
High frequency waves have short wavelengths which are smaller than normal duct dimensions. If there is a contraction within the duct, some sound will be reflected back up the duct and some transmitted. The transmission coefficient (T) is simply given by:

$T = S_2/S_1$ where S_1 is the original duct area and S_2 the changed duct area.

At enlargements all sound power is transmitted (although the sound pressure level will change)
Larger wavelengths need to be treated differently. A similar approach to that employed earlier in determining boundary transmission needs to be employed (velocity and pressure continuity).

This leads to a transmission coefficient = $4(S_1/S_2)/(1 + S_1/S_2)^2$
and an end reflection at low frequencies with sudden enlargements.

End reflection is a useful source of low frequency sound attenuation in ducts. Plenum and expansion chambers and multiple systems of expansion and contraction can provide good low/mid frequency absorption and are known as reactive systems. Mid/high frequency noise is better controlled by absorptive silencers. Ducts themselves bend and flex and absorb some sound. By lining the ducts internally with absorber the attenuation is given by:

Attenuation = $3.5\ \alpha^{1.4}$ P/S dB per metre

where α is the absorption coefficient
P is the perimeter of the duct in metres
S is the cross-sectional area of the duct in square metres

To increase the area of absorber splitters are often used. To avoid regenerated noise, that is aerodynamic noise generated by the increased air flow, the cross-sectional area available within the silencer should not be less than that in the duct. Care must be taken with ducts to avoid noise breakout and breakin. Either the duct should be well insulated or the silencer placed at the partition junction where the duct moves from a noisy to quiet area. In critical situations the duct should be suspended by resilient hangers to avoid structure borne transmission.

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Additional Useful Reading

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M. Wilson *A Review of Acoustic Problems in Passive Solar Design*, Proc IOA Vol 14 Part4 (1992) (Euronoise '92) ISBN 1- 873082 See Appendix 1

Appendix 1

A REVIEW OF ACOUSTIC PROBLEMS IN PASSIVE SOLAR DESIGN

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INTRODUCTION

The future of the planet may well depend on us changing our attitudes to the design of buildings. We can no longer afford the building equivalent of the 'gas guzzler'.
Passive Solar Design uses renewable energy to limit fossil fuel consumption.