BRITISH ACOUSTICAL SOCIETY

Systems Noise in Buildings

25th and 26th September 1969

# The Control of Ventilation Noise

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Previous contributors have discussed the generation of noise by fans and elsewhere in ventilating and air-conditioning systems. Noise occurring anywhere in a ventilating system will be communicated to the terminal rooms by the ductwork in much the same way as old-fashioned speaking tubes conveyed voice messages. Most ventilation systems, however, will contain natural attenuation which will contribute to the reduction of the fan noise sensed in the conditioned areas. This natural attenuation can be grouped under five main headings:

1. Loss of Acoustic Energy due to Transmission through the Duct Walls

Acoustic energy can be dissipated from within the ductwork due to transmission through duct walls. However, since most ducts at some point pass through conditioned areas, such a form of introduction is generally inadmissible.

2. Absorption of Sound in the Duct Wall Linings

Rectangular sheet metal ducts with large expanses of flat and relatively flexible walls will contribute useful low frequency absorption by functioning as membrane absorbers. Circular section ducts and rigidly braced rectangular ducts contribute little of this type of absorption. If the walls of the duct are covered internally with a sound absorbent material, then significant amounts of high frequency attenuation will be introduced and the concept of the lined duct can be extended to the point where a greater quantity of absorbent material is introduced than could be accommodated round the periphery - an arrangement which is typified by the purpose-made dissipative silencer, where additional absorbing surfaces are introduced into the duct section by means of absorbent pods or splitters.

3. Division of Sound at each successive Branch

When the airflow in a duct divides at a branch or junction, an equivalent division of the acoustic energy will occur. When the energy transmitted by a branch to a conditioned area is considered, such a division of acoustic energy may be viewed as the virtual reduction in the fan noise transmitted to that terminal unit.

4. Reflection of Sound back towards the Source at Changes in Area or Direction

Whenever the airflow changes in direction attenuation is obtained by incident sound being reflected back towards its source. Noise is always reflected at mitre bends if the cross dimension of the duct is sufficiently large. The attenuation so produced can be improved by incorporating absorbent linings. Radiused bends or mitre bends incorporating turning vanes introduce relatively little attenuation into a system. At an abrupt change in cross-sectional area sound is also reflected back towards the source. This component of natural attenuation is very low at normal duct expansion or contractions, but where the duct terminates in a conditioned space at a grille or diffuser the insertion loss due to the change in area is referred to as 'end reflection loss' and may introduce a significant amount of low frequency attenuation into the total system.

5. Variation of Sound Pressure Level in the Conditioned Area due to Distance from the Terminal Unit and the Room Acoustics

The sound power entering a conditioned area is dependent only on the sound power of the virtual source and the natural attenuation of the ductwork. The sound pressure level at any point in the conditioned space, however, will be dependent on room dimensions, room reverberation time, distance to the source, and the presence of any acoustic screening between the source and the recipient. When a room is conditioned by a multiplicity of grilles and diffusers, the total sound power level must be determined by addition of all the individual sources of noise.

Comparison of the resultant sound pressure level in a room due to noise transmitted from the fan and the design criterion for that room will determine whether any additional noise control is required. This will normally be introduced by the provision of purpose-built attenuation in the form of plenum chambers at the fan, or purpose-built dissipative silencers throughout the system.

Not all noise occurring in air-conditioned buildings is generated by the fans. Some of the noise may be attributable to vibration, bearing noise, structural resonance of fan casings or motor noise or noise arising at couplings and belt drives. Noise in the form of cross-talk may be transmitted between rooms along ducts and noise from the external environment may reach conditioned areas through pressure relief ports in walls, via convector fan units,etc. In the design of the total system due allowance should be made for all of these problems and the standard methods for their control should be applied as and when necessary.