MODULE 123

HVAC&R SKILLS WORKSHOP

MANAGING NOISE IN DUCTWORK SYSTEMS

Skills summary

What?

Noise in ductwork systems.

Who?

Graduate mechanical engineers, HVAC&R technicians, maintenance personnel, and practitioners involved in the design and/or day-to-day operations of HVAC&R systems.

In many air conditioning systems, ductwork is used to reticulate the conditioned air to and from the spaces to be served.

The noise level requirements of the areas to be served can affect the layout of the ductwork, the size of the ducts and the extent of any noise treatment required. The capital cost of the ductwork, the running costs and the cost of providing space for the ductwork can all be affected as a consequence.

Because of the computational effort involved, the noise level requirements are often given scant attention.

This Skills Workshop looks at how noise is generated in ductwork systems and transmitted to the air conditioned or adjacent spaces. It also looks at strategies you can use to reduce ductwork noise.

PULLOUT

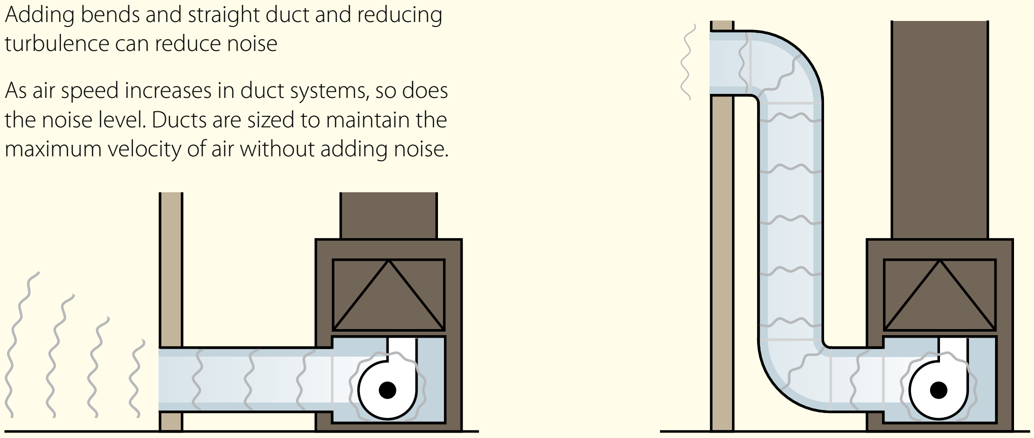
Noise in ductwork systems

Noise from the equipment, ducts, or air outlets is an important part of the comfort equation. The placement of equipment must consider the impact of equipment noise during operation and may involve consideration of noise and vibration. Adding bends and straight duct and reducing turbulence can reduce noise

As air speed increases in duct systems, so does the noise level. Ducts are sized to maintain the maximum velocity of air without adding noise.

Generation of noise in ducts

Noise in ductwork systems is often a very important aspect of ductwork design. Poorly executed designs can cause noise generation by the ductwork system, which may lead to complaints.



Adding bends and straight duct to reduce noise

Noise in ductwork systems is generated by:

- The fan
- Air terminals
- VAV boxes
- Dampers and other fittings
- Ducts.

The noise passes down the ductwork system and enters the room, where the acoustical properties of the room determine the final noise level.

Noise and air velocity

There is a direct relationship between duct air velocity and the noise generated by the airflow. All other things being equal, increasing air velocity causes more turbulence and more noise. Table 1 provides some guidelines on recommended maximum duct velocity for specific noise outcomes, but designers should always select and check appropriate duct sizes to suit the specific project's noise criteria. The table is only applicable to systems greater than 1,000L/s and provides absolute maximum duct velocities, not recommended design velocities.

Table 1 – Maximum duct velocities and noise effects

Required NR level	Riser velocity (m/s)	Main supply duct velocity (m/s)	Branch duct velocity (m/s)	Run-out velocity (m/s)	Return duct velocity (m/s)
50	10.0	10.0	8.0	6.0	8.0
45	10.0	9.0	7.0	6.0	7.0
40	10.0	8.0	7.0	5.5	7.0
35	10.0	7.5	6.5	5.0	6.5
30	9.0	6.5	5.5	4.0	5.5

Noise from outlets

The type of air outlet chosen and its placement in the space will have an impact on noise levels. Air that leaves an air outlet at a higher velocity than the outlet is intended to handle will create an undesirable whistling or hissing noise. Improperly placed or selected air outlets can also create drafts in the occupied zone, which is a comfort issue.

When selecting an air outlet, consult the manufacturer's performance data, which will list a comparative noise criteria (NC) rating

Noise frequencies

Low-frequency noise

Low-frequency noise can break out of or break into a duct and be transferred with the airstream.

For rectangular ducts:

- Use rectangular ducts where breakout noise is beneficial
- Do not use where break-in noise is a concern.

Round ducts:

- Do not allow as much breakout
- Do not allow as much break-in.

Acoustic liners:

- Thicker liner typically attenuates lower frequencies.

More mass in the duct walls is better at attenuating lower frequencies.

Medium-high frequency noise

Medium-frequency and high-frequency noise tends to be easier to attenuate than low-frequency noise.

Lined or double-walled ducts can provide good attenuation.

Lengthen duct runs if necessary (on the non-index run) to provide additional attenuation.

Silencers can be effective at attenuating specific targeted sound frequencies.

Silencers

Duct-mounted silencers can be very effective at attenuating airborne noise in ducts.

Silencers are generally designed and tested to provide a specific "Insertion loss".

Pressure drops need to be considered, particularly on the index run.

Reactive silencers have low pressure drops.

Dissipative silencers have no fill, they use baffles and chambers to attenuate noise.

Controlling noise

Noise is controlled in a variety of ways.

- Internally lining ductwork with acoustic absorbing insulation (bare ducts provide limited attenuation)
- Increasing duct size will reduce air velocity and noise
- Attenuation effect of fittings
- Changing the layout to introduce more bends or longer duct runs
- Fan selection to change fan noise
- Inserting silencers
- Changing the acoustical properties of the room.

To avoid noise issues:

- Start with quiet equipment
- Locate air-handling equipment in less sensitive areas
- Allow for proper fan outlet conditions
- Address "system effect"
- Use radiused elbows where possible
- Larger ductwork reduces velocity and reduces generated noise
- Avoid abrupt changes in layout
- Place dampers away from outlets
- Provide flexible connections to equipment.

There are various calculations involved in determining noise levels from a ductwork system.

These calculations are complex and invariably require the use of a computer program.

Further information can be found in the AIRAH ***DA03 Ductwork for Air Conditioning*** manual.

PULLOUT

Table 2 – Comparative NC values

	Communication environment	Typical occupancy
<NC25	Extremely quiet environment; suppressed speech is quite audible; suitable for acute pickup of all sounds.	Broadcasting studios, concert halls, music rooms.
NC 30	Very quiet office; suitable for large conferences; telephone use satisfactory.	Residences, theatres, libraries, executive offices, director's rooms.
NC 35	Quiet office; satisfactory for conference at a 5m table; normal voice 3 to 10m; telephone use satisfactory.	Private offices, schools, hotel guestrooms, courtrooms, churches,hospital rooms.
NC 40	Satisfactory for conference at a 2 to 3m table; telephone use satisfactory.	General office, labs, dining rooms.
NC 45	Satisfactory for conference at a 1½ to 2m table; normal voice 1 to 2m, raised voice 2 to 4m; telephone use occasionally difficult.	Retail stores, cafeterias, lobby areas, large drafting and engineering offices, reception areas.
>NC 50	Unsatisfactory for conferences of more than 2 or 3 persons; normal voice 300mm to 600mm, raised voice 1 to 2m; telephone use slightly difficult.	Computer rooms, stenographic pools, print machine rooms, process areas.

Designing ductwork to minimise noise regeneration

Maintain the air velocity in the duct as low as practicable. The design of fittings can have a significant impact on system resistance and fan operating energy requirement. Providing low pressure drop and laminar flows across ducts and fittings will minimise the potential for regenerated noise.

Elbows

Use long radius elbows with full radius turning vanes for maximum noise reductions.

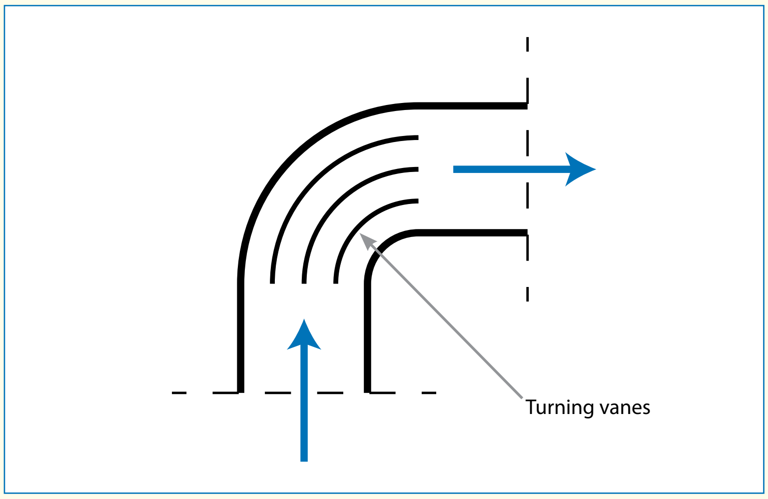
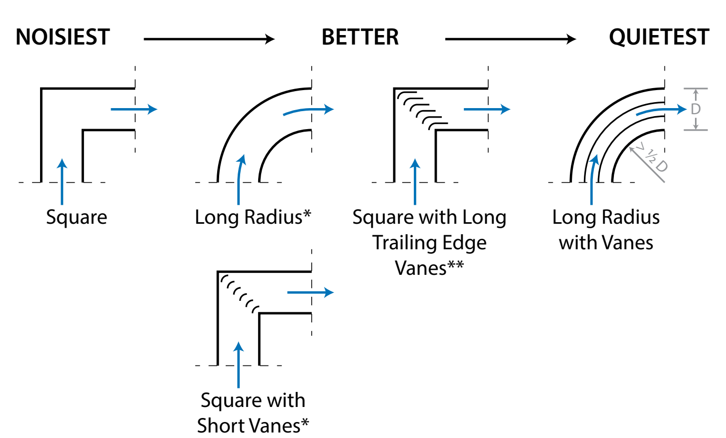


Figure 1

Long radius elbows without vanes and square elbows with short vanes are satisfactory for most applications.

Square elbows without vanes should be avoided. See figure 2.



* Airflow velocity and proximity of upstream and downstream fittings and fans determine which type is preferable.

** Trailing edge length should be at least 3 times the vane spacing.

Figure 2 – Guidelines for minimising regenerated noise in elbows.

Branch takeoffs

Radius or bevel branch takeoffs are preferable to Y or straight takeoffs. See figure 3.

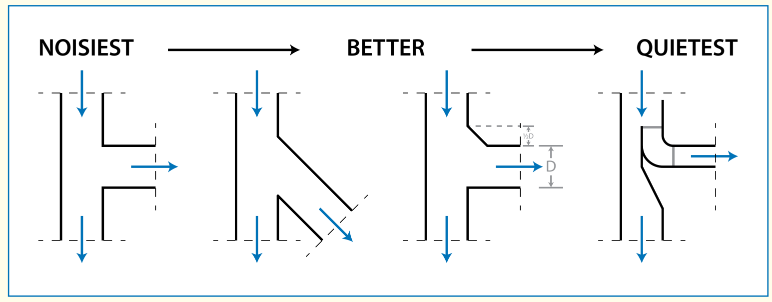


Figure 3 – Guidelines for minimising regenerated noise in takeoffs.

Tees

Keep airflows as laminar as possible, use turning vanes at all diverging T connections.

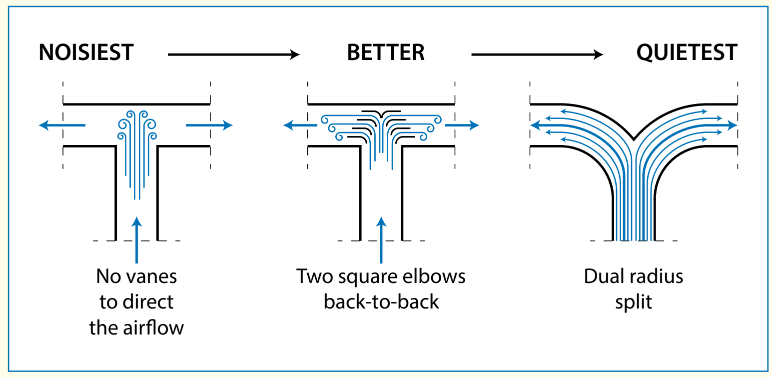


Figure 4 – Guidelines for minimising regenerated noise in duct tees.

Offsets

Avoid using Z-offsets without turning vanes.

Gradual offsets (15° maximum) are preferable to Z-offsets with turning vanes. See figure 5.

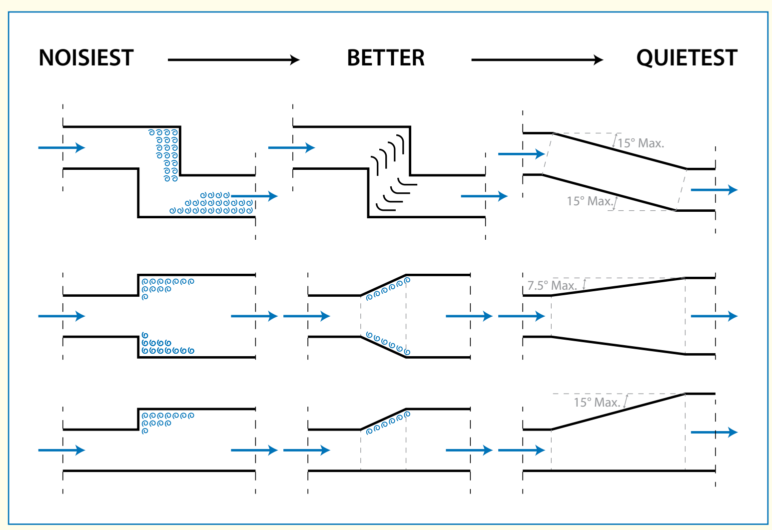


Figure 5 – Guidelines for minimising regenerated noise in transitions and offsets.

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Next month: Controls fundamentals