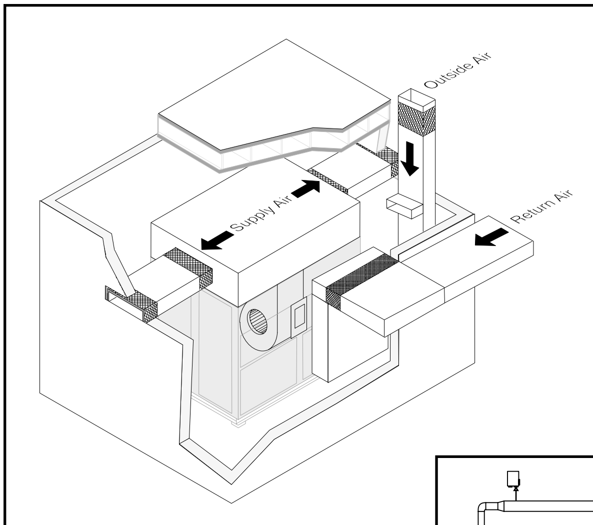
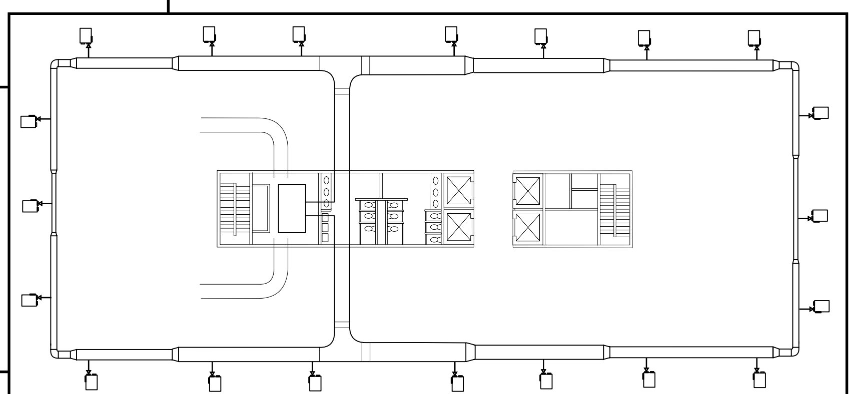
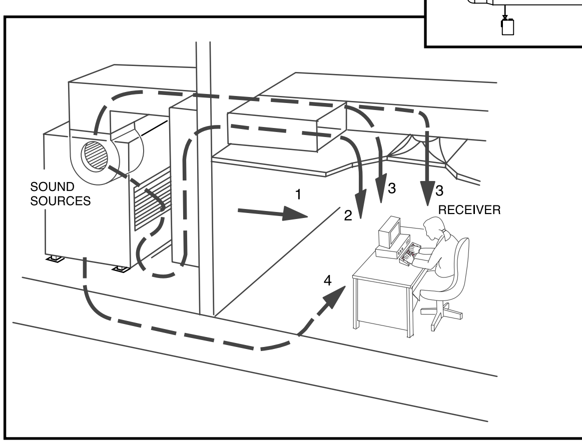
Achieving A Quieter Environment With McQuay® Indoor Vertical Self-Contained Systems







McQuay Air Conditioning

Introduction

This application manual provides a common sense approach to achieving a quieter tenant environment when using McQuay SWP and SWT Self-Contained systems. Its objective is to provide general guidelines that, when used with sound installation practices, will achieve low sound levels in any building environment when using McQuay Self-Contained systems.

The information contained in this manual is based on the experience gained through twenty-two years of designing and manufacturing self-contained systems. We have incorporated information gathered through collaborations with prominent sound consultants and from ASHRAE recommendations, as well as experience in achieving low NC levels on major projects using McQuay Self-Contained Systems.

McQuay SWP Vertical Self-Contained System For New Construction Applications

What is Sound - What is Noise?

Sound can be defined as pulses of pressure in air occurring at different intensities and different frequencies. Pleasant sounds include music and speech. Unpleasant and unwanted sounds can be defined as noise.

In the acoustic design of a typical office building air conditioning system, the designer attempts to reduce "noise" to a level that is not annoying while, at the same time, maintaining a non-offensive background "masking" noise to provide speech privacy.

McQuay SWT Vertical Self-Contained System For Retrofit Applications

Sound Power vs. Sound Pressure

It is important to distinguish between sound power and sound pressure. Self-contained units generate sound power. The human ear hears sound pressure. The difference between the sound power that the unit generates and the sound pressure that the ear hears is caused by the reduction (attenuation) of the sound along the path to the room, and the reduction within the room (or "room effect") caused by the room layout, construction and furnishings.

Where Noise Comes From

There are four primary noise/vibration transmission paths (Figure 1) from the equipment to the occupied space in the building:

1. Noise in the mechanical equipment room (MER), which radiates from the unit casing and intake through the room enclosure (walls, doors, etc.).
2. Noise in the MER, which radiates from the unit casing and intake through the return air path.
3. Noise generated as air exits the MER into occupied spaces through the supply air duct. This includes noise from diffusers and breakout noise from the supply air duct.
4. Vibration and structure-borne noise transmission to a building.

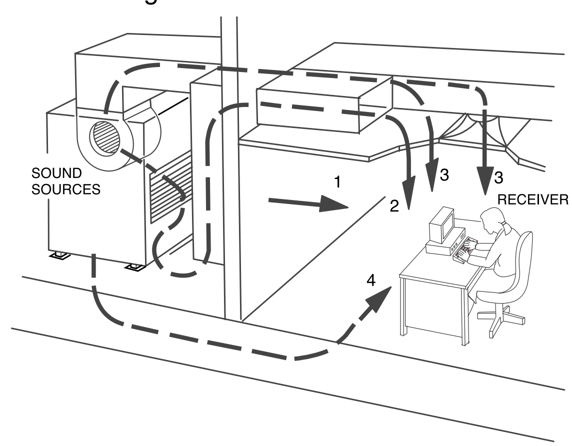


Figure 1. Noise Transmission Paths

Decibels (dB)

A decibel (dB) is the common unit of measurement for sound. It is expressed as 10 times the common logarithm of the ratio of a sound level to a specified reference level. A logarithmic ratio is used for convenience to compress the scale to manageable dimensions. For example, the range of 10 to 120 decibels of sound pressure (the threshold of hearing to the threshold of pain), without using logarithms, would extend over 1,000,000,000,000 (10^{12}) units which, of course, could not be charted in a useable manner.

A decibel scale can be used for many purposes, but it is meaningful for a specific purpose only when the reference level is defined. In acoustical work, two reference levels are commonly used. **Sound Power Level** (L_w) is a measure of sound energy output expressed in decibels compared to a reference unit of 10^{-12} Watts. It is calculated by the formula:

$$L_w = 10 \text{ Log}_{10} (\text{Watts}/10^{-12})$$

Sound Pressure Level (L_p) is a measure of sound pressure at a specific point, also expressed in decibels. The reference unit is .002 Microbars. It can be found from the following formula:

$$L_p = 10 \text{ Log}_{10} (\text{Microbars})2/.002 \text{ or } 20 \text{ Log}_{10} (\text{Microbars})/.002$$

Note: 1 Microbar = Atmospheric Pressure/1,000,000.

Human Ears Are Sensitive

As mentioned above, human ears can "hear" sound pressure levels ranging from a low of 10 decibels (leaves rustling), the threshold of hearing, to a high of 120 decibels (a jet engine at the ramp), the threshold of pain. This is a 10^{12} multiple of pressure.

Note also that the human ear is able to hear frequencies as low as 10 - 15 Hz, the lower end of human hearing, to 20 to 25,000 Hz at the upper end.

Human responses to changes in sound pressure are also important to understand (Table 1).

Table 1. Subjective Effects of Changes in Sound Pressure Level - Broad Band Sounds

Change in Sound Pressure Level	Apparent Change in Loudness
3 dB (Double the Pressure Level)	Just Noticeable
5 dB (Three Times the Pressure Level)	Clearly Noticeable
10 dB (Ten Times the Pressure Level)	Twice (or Half) as Loud

Human ears are very sensitive and can be used to analyze and solve noise problems!

Noise Criteria

In acoustic analysis, the air conditioning designer is concerned with what the human ear perceives. The "loudness" of the sound is based not so much on absolute numbers, as on the human ear's perception. The human ear responds differently to loudness at different frequencies. A series of curves, called Noise Criteria (NC), plotted on a scale of Frequencies (Octaves) vs. Decibels (Loudness in dB), represent approximately equal loudness levels to the human ear (Figure 2). These curves define the limits that the octave band spectrum must not exceed. For instance, to achieve NC-35 rating, the sound spectrum must be lower than the curve in every octave band. This is described as tangency rating procedure.

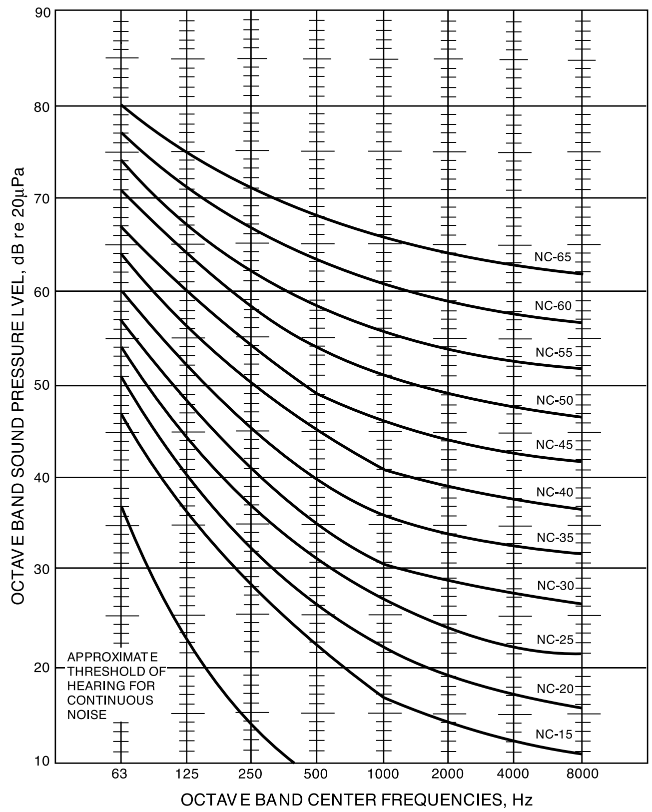


Figure 2. Noise Criterion Curves

While NC rating of noise from HVAC equipment is an important tool, one needs to keep its limitations in mind. First, due to the tangency method, two different sounding noise spectra with different acceptance from people may be rated at the same NC level. For example, equipment with a dominant single low frequency peak will sound much more offensive than equipment with a spectrum that more closely matches the NC curve. For self-contained units, it is important to compare the noise generated in the first (63 Hz) and second (125 Hz) octave bands. Higher noise in these octave bands can cause a rumble in the conditioned space.

Second, the level of resultant background noise may be lower than that desired for masking unwanted speech and activity noises. This is particularly true when a plenum fan within an acoustically insulated housing discharges air into another plenum before entering the supply duct. Higher frequency sound, which is much easier to attenuate with acoustic insulation, is reduced significantly and is unable to mask unwanted sound. Low frequency noise is attenuated much less, causing the annoying rumble.

Watch the Lower Octave Bands

The insertion loss, or decrease in sound power level over a length of duct, illustrates why it is important to pay particular attention to lower octave bands. The insertion loss in the 125 Hz octave band for a 24"X48" duct with 2" lining is 2 dB over a 10' length of duct. For the same duct, the insertion losses for the 250 Hz and 500 Hz octave bands are 7 dB and 22 dB respectively (see Table 4). According to the 1999 ASHRAE HVAC Applications Handbook, this pattern also holds true for transmission losses through ceiling tile, walls, floors and other building materials. Consult the Handbook for more detailed information about insertion losses.

Generally speaking, if the equipment sound levels are lower in the first and second octave bands (63 Hz and 125 Hz), the project will be quiet.

How To Address Noise

The generally accepted sound level for tenanted spaces is NC-40. However, sound levels in the NC-30's can be achieved by addressing the same basic issues required to achieve NC-40. They are as follows:

A. The design of the self-contained unit itself and the discharge air plenum.
B. The location, size and construction of the mechanical equipment room (MER).
C. The design of the supply and return air ducts.

A. Unit And Discharge Plenum Design

1. Unit Design.

Not all units are alike. Sound power levels provide a clear comparison of the sound performance of different equipment. It is also the starting place for working out the sound level in the occupied space.

Using equipment with lower sound power levels will be better in terms of both first cost and operating cost. Specify the equipment sound power levels that work with the acoustic treatments used to meet the design sound level. By doing this, the plans and specifications will include an acoustic solution. If equipment with higher sound levels is proposed, it is a straightforward matter to improve the acoustic treatments to meet the desired sound level. However, this will result in additional project costs.

McQuay's Vertical Self-Contained system is designed to achieve low NC levels in good or less than perfect building and MER conditions. Octave band sound power data (discharge, return and casing radiated) that has been verified in independent laboratory testing is available for this equipment. The data demonstrates the particularly low sound power levels of McQuay self contained equipment in the lower octave bands.

The following features available in McQuay self-contained equipment will help reduce the noise radiated from the unit to the MER and the ducts:

- A fully housed DWDI supply fan with a gradually expanded ducted discharge minimizes turbulence and vibration within the unit cabinet.
- Fan housing is encased in 10 gauge galvanized steel panels to minimize housing vibration.
- Internal spring isolators and a flex connection within the unit ducted discharge isolate fan and motor vibrations from the unit casing and base.
- Neoprene isolation pads under unit base minimize vibration transmission to the floor.
- 1/4" thick tubular steel welded fan and motor base assembly adds structural integrity to minimize fan and motor vibration.
- Fan rotation options, based on duct orientation, to reduce system turbulence.
- Factory-installed inverter reduces airflow and noise.
- Heavy density insulation and options for perforated metal liners absorb noise.
- Heavy duty industrial cabinet with welded 1/4" structural and tubular steel assemblies minimize unit vibration.
- Scroll compressors with vibration isolators, located out of the supply air stream in an insulated compartment, minimize compressor noise entering the airstream so that it doesn't affect NC levels outside the MER.
- Two series of unit designs, SWP and SWT, that allow the specifier to select the right unit configuration based on the physical constraints of the mechanical equipment room and achieve the lowest sound levels in occupied spaces.
- Ability to deliver low temperature supply air at reduced air quantities, resulting in reduced duct velocities, system pressure and noise levels.

2. Plenum Design.

Plenums can provide a substantial reduction in outlet noise that is critical for achieving low NC levels outside the MER. However, not all plenums are alike. It is essential that a plenum with the following features be part of the overall acoustic solution:

- 18-gauge outer casing to provide maximum stability and minimize vibration.
- 3" insulation provides a significantly higher sound absorption coefficient for the critical lower octave bands versus 2" insulation (Table 2).
- 3-pound/ft^3 density insulation provides higher sound absorption coefficient for the critical lower octave bands versus 1½-pound/ft^3 density insulation.
- Perforated sheet metal lining over all insulation to protect it from erosion and enhance sound attenuation.
- Factory-supplied duct connections to provide a proper fit and avoid exposed insulation from field cut duct openings.
- Internal baffles to minimize turbulence in the plenum, reducing the mechanical energy and noise.

Table 2 - Sound Absorption Coefficients of Selected Plenum Materials.

	Octave Band Center Frequency (HZ)						
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**
Non-Sound-Absorbing Material							
Concrete	0.01	0.01	0.01	0.02	0.02	0.02	0.04
Bare Sheet Metal	0.04	0.04	0.04	0.05	0.05	0.05	0.07
Sound-Absorbing Material (Fiberglass Insulation Board)							
1 in., 3.0 lb/ft3	0.05	0.11	0.28	0.68	0.90	0.93	0.96
2 in., 3.0 lb/ft3	0.10	0.17	0.86	1.00	1.00	1.00	1.00
3 in., 3.0 lb/ft3	0.30	0.53	1.00	1.00	1.00	1.00	1.00
4 in., 3.0 lb/ft3	0.50	0.84	1.00	1.00	1.00	1.00	0.97

Note: The 3" insulation used in McQuay supply air discharge plenums has an absorption coefficient that is 3 times higher than 2" insulation and 5 times higher than 1" insulation in the critical low octave bands (63 and 125 Hz). Similarly, the 3-pound/ft^3 density of the insulation used in McQuay supply air discharge plenums provides significantly more sound attenuation as compared to 1½-pound/ft^3 density insulation.

B. Mechanical Equipment Room (MER)

A quiet unit is only part of the complete noise control equation. The building design and construction impact the ability to achieve desirable acoustic levels in occupied spaces. Three issues must be addressed:

1. MER location.
2. MER size.
3. MER construction.

1. MER Location

MERs should be located away from sensitive areas. If possible, isolate the equipment room by locating rest rooms and corridors around its perimeter (Figure 3). The benefits of this type of placement include:

- Isolates the radiated sound from the MER to less sound sensitive areas.
- Allows the ductwork to be routed over less sensitive areas putting more distance between the unit and office spaces.

Locating the MER next to elevator shafts and stairwells can be advantageous. However, it can also limit the amount of ducts exiting the MER. When larger air quantities are forced to exit the MER with fewer ducts, the NC levels can be unacceptable.

2. MER Size

As a rule, the larger the MER room, the quieter the Self-Contained system will be. Putting distance between the unit discharge and the walls helps reduce fan noise emissions to occupied spaces. However, the reality is that space is at a premium, particularly in office buildings or retrofit applications. As a result, MERs are usually designed to provide the minimum clearance on all sides, resulting in more stringent construction requirements for the MER.

Figure 4 shows the recommended minimum clearance required for McQuay Self-Contained units. Clearance is required to allow for side filter access, mechanical cleaning of the condenser tubes and economizer coil,

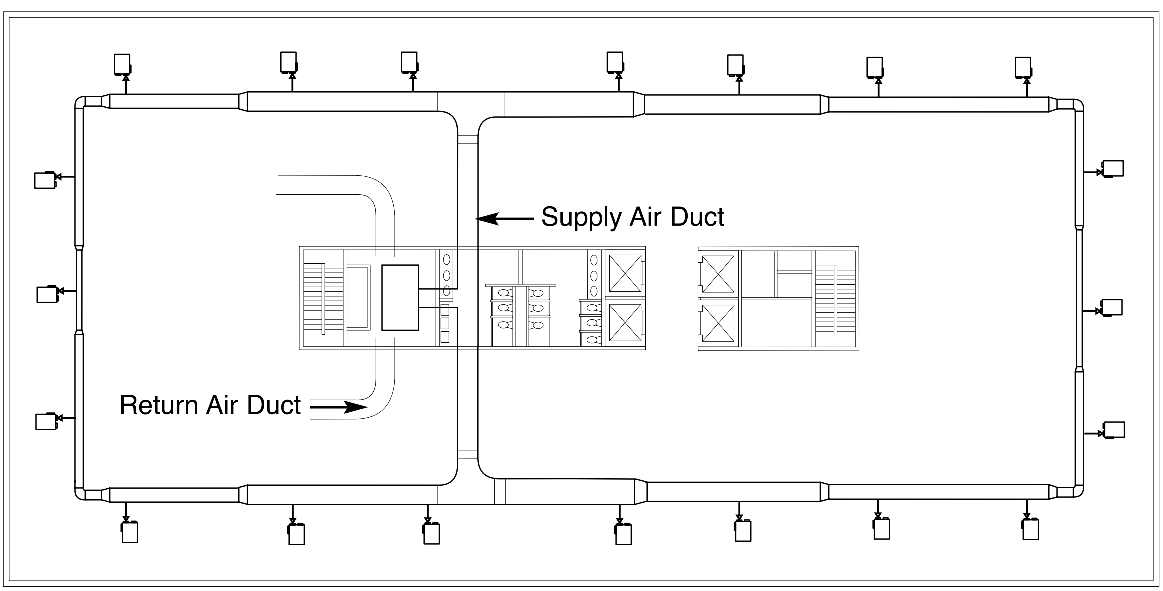


Figure 3. Isolated MER Floor Plan. *Locating the MER away from sound sensitive areas can provide for easier noise control.*

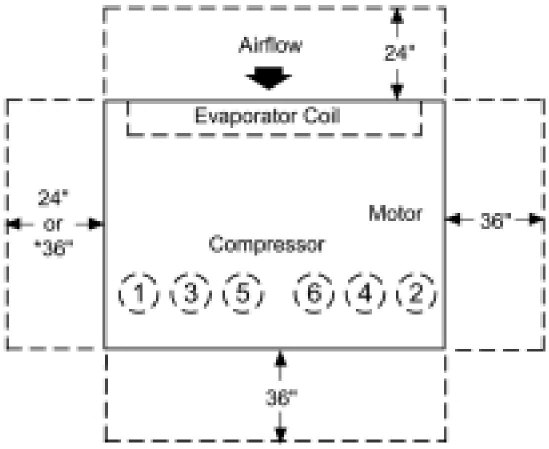


Figure 4. Recommended Clearances.

access to expansion valves and other control components, and to allow for possible fan motor and shaft or compressor removal. Code considerations, such as National Electric Code (NEC), that require extended clearances take precedence over these recommendations. Contact your local McQuay representative if smaller service/maintenance clearances are required.

3. MER Construction

The desired noise levels in the adjacent space and the amount of airflow determine the requirements for MER wall construction. Guidelines are provided in Table 3:

Table 3. Recommended MER Wall Constructions.
Match the CFM and room characteristics (open or closed office area) with the list of construction guidelines.

Total CFM in room	Noise Goal In Adjacent Space					
	NC 30-35		NC 35-40		NC 40-45	
	Open	Closed	Open	Closed	Open	Closed
8,000-12,700	3	4	2	3	1	2
12,700-20,200	4	5	3	4	2	3
20,200-32,000	5	6	4	5	3	4

Construction Guidelines:

1. Single 3-5/8” stud with one layer 5/8” gypsum board on each side and glass fiber batt insulation in the stud cavity.
2. Single 3-5/8” stud with two layers 1/2” gypsum board on one side, one layer of 1/2” gypsum board on the other side and glass fiber batt insulation in the stud cavity.
3. Single 3-5/8” stud with two layers 1/2” gypsum board on each side and glass fiber batt insulation in the stud cavity.
4. Single 3-5/8” stud with two layers 5/8” gypsum board on each side and glass fiber batt insulation in the stud cavity.
5. 6” hollow concrete block with 1/2” gypsum board rigidly furred to the office side of the wall; or a single row of 3-5/8” studs with three layers of 5/8” gypsum board and glass fiber insulation in the stud cavity; or double studs with two layers of 5/8” gypsum board on each side and glass fiber batt insulation in the stud cavity.
6. 6” hollow concrete block with separately studded two layers of 1/2” gypsum board on the finished side (not in contact with the block) and with glass fiber batt insulation in the stud cavity.

Note: Construction guidelines are representative only and address noise transmission through the MER wall only. Actual sound levels will depend on how all transmission paths are addressed.

All wall constructions must extend up to and be sealed to the floor construction above. This includes sealing between the ribs of the floor construction. If the wall is located under a beam, the space between the top of the beam and the deck must also be sealed.
All penetrations of MER walls must be sealed airtight. The supply duct penetration must also remain resilient, avoiding rigid contact between the duct and the wall. The space between the duct and the wall should be packed with glass fiber insulation and be closed to a 1/2” wide gap. This gap should then be sealed with a permanently resilient sealant such as silicone caulk or acoustical sealant (Figure 5).

Wherever possible, plan the entrance to the MER from a non-critical buffer space such as a freight elevator lobby or janitor’s closet. If this is done, a solid core wood door or hollow metal door with glass fiber packing may be used. The door should have quality gaskets and drop seals to form an airtight seal all around.

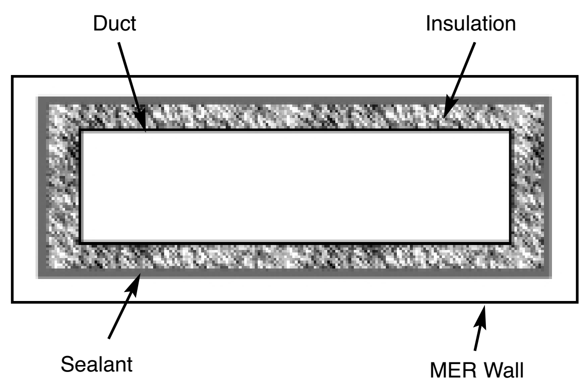


Figure 5. Sealing Supply Duct Penetrations.

If the door to the mechanical room leads directly from an open or closed office space requiring NC-35 to 40 sound levels, special acoustically rated doors achieving at least STC 45 (open) and STC 50 (closed) should be used. Alternatively, conventional gasketed doors in a sound lock vestibule configuration could be used. However, using sound lock vestibules with gasketed conventional doors is always a more reliable noise control solution in the long run than acoustically rated and single gasketed doors.

Finally, MER doors should have only one leaf. Double leaf doors are extremely difficult to seal and should be avoided. If double leaf doors are necessary, a construction that is one grade higher than what is ordinarily required should be used.

C. Supply and Return Duct Treatments

In concert with the self-contained air conditioning unit, the design of the supply and return air ducts is the most determinate factor in achieving a quiet environment. Our recommendations are restricted to rectangular ducts due to the lack of space available on most building projects to accommodate round insulated ducts. Round ducts are stiffer than rectangular ducts, eliminating the need to address the rumbling sound associated with pouting, which is caused by improperly designed rectangular ducts used in tenanted areas. Please refer to Table 4 for information on insertion losses for common sized round and rectangular ducts. Refer to Tables 8 through 12 on pages 46.12 and 46.13 of the ASHRAE Handbook for more detailed information on insertion losses.

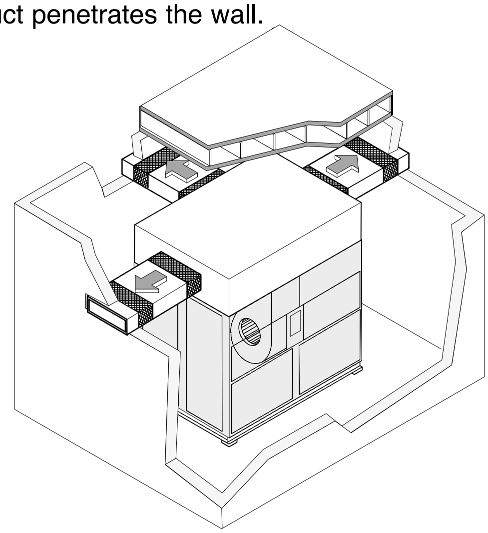
Table 4. Insertion Losses For Common Sized Ducts.

Type	Lining	Dimension(s)	Insertion loss, dB/ft					
			Octave Band Center Frequency, Hz					
			125	250	500	1000	2000	4000
Rectangular	1”	18” x 36”	0.2	0.5	1.4	2.8	2.2	1.8
Rectangular	1”	18” x 54”	0.2	0.4	1.3	2.7	2.0	1.7
Rectangular	1”	24” x 48”	0.2	0.4	1.2	2.4	1.7	1.5
Rectangular	2”	18” x 36”	0.3	0.9	2.5	3.5	2.2	1.8
Rectangular	2”	18” x 54”	0.3	0.8	2.3	3.3	2.0	1.7
Rectangular	2”	24” x 48”	0.2	0.7	2.2	3.0	1.7	1.5
Round	1”	30” Diameter	0.16	0.45	1.16	1.33	0.95	0.69
Round	1”	36” Diameter	0.08	0.35	1.02	0.93	0.71	0.60
Round	1”	38” Diameter	0.06	0.31	0.96	0.80	0.64	0.58

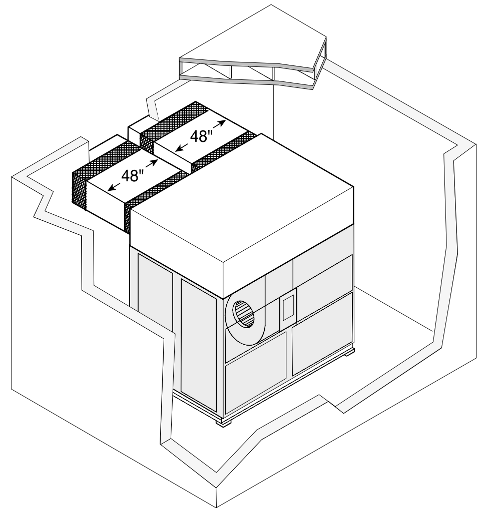
Supply Duct

The most critical segment of the duct system is from the unit discharge to twenty feet beyond the MER wall. Therefore, we recommend a double skin ductmate design for supply ducts through the first twenty feet beyond the MER wall. The following are recommendations for the design and construction of supply ducts:

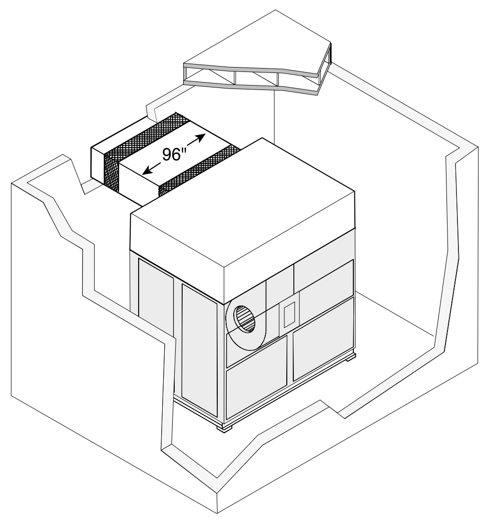
1. Use a flexible connection at the fan or plenum discharge. If space permits, use a second flexible connection inside the equipment room before the duct penetrates the wall.



2. Where possible, the duct(s) should be less than 54” wide. Split larger ducts (>54” wide) into two.

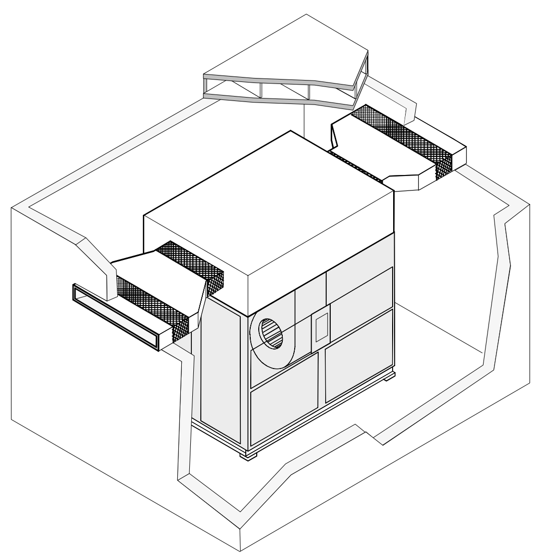


Recommended

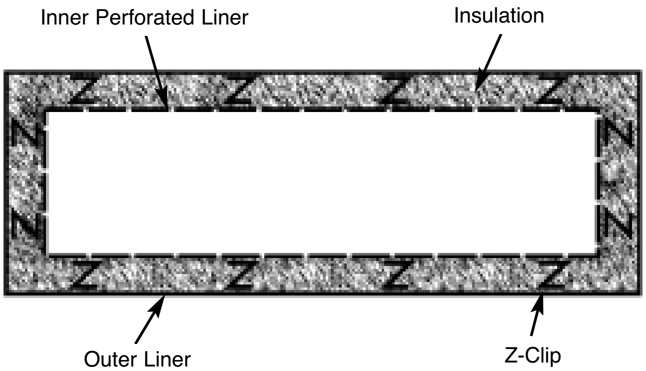


Not Recommended

3. If necessary, gradually expand duct takeoffs from the plenum.

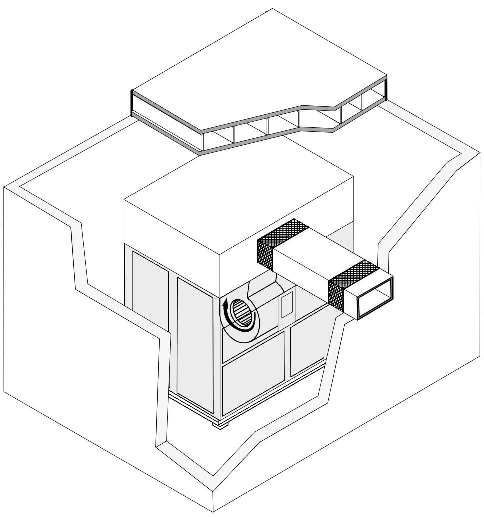


4. Use Ductmate® double skin duct design where possible.



Ductmate is a registered trademark of Ductmate Industries, Inc.

5. Avoid ducting air in the opposite direction of the fan rotation.



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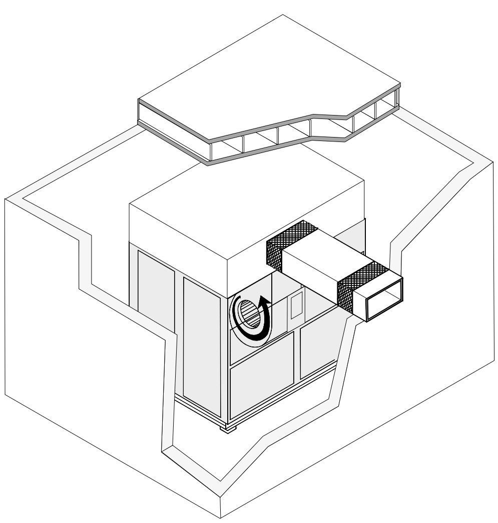
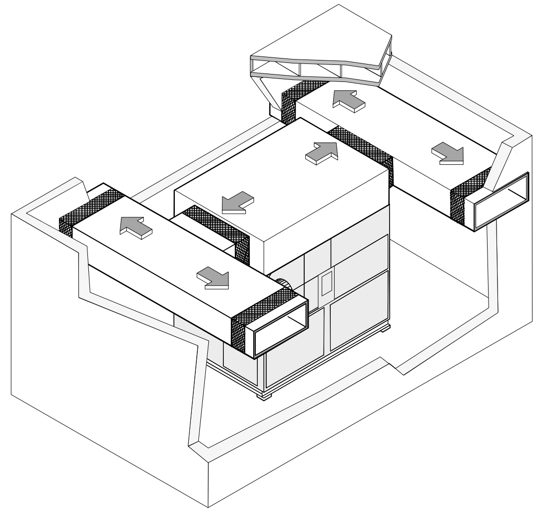


Not Recommended

6. Keep the supply air duct velocity from exceeding 2000 fpm, preferably 1500 fpm in occupied spaces. If necessary, exit the equipment room using multiple ducts.

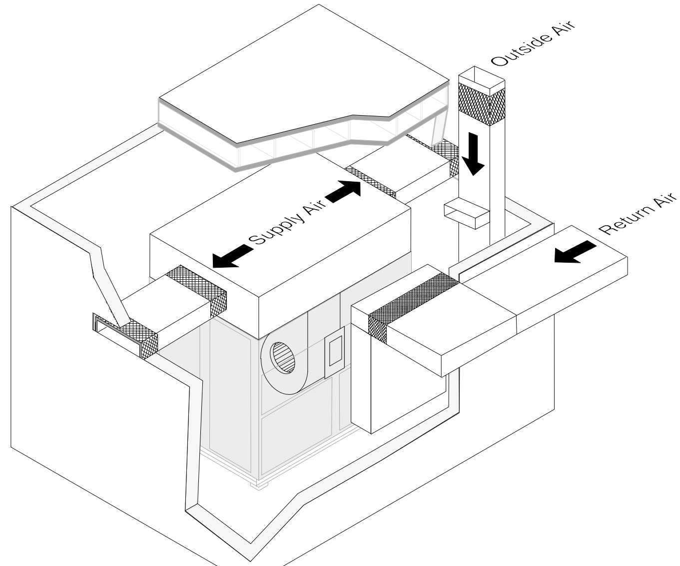


As it enters occupied space, the supply duct must not contact anything in the ceiling including conduits, pipes, other ducts, lights, etc. The ceiling must not contact or be supported from the duct. When wide ducts are used, it may be necessary to provide a supplemental support frame for the ceiling to avoid contact with the duct.

Return Duct

The following are examples of return air designs, some of which are recommended and some of which are poor. In addition to the information provided in the drawings, other factors that influence noise in the return duct are:

1. The return ducts should be of adequate length to properly absorb the radiated noise from the MER.
2. The return duct should be properly insulated to absorb the radiated noise from the MER.
3. The maximum velocity of air through the return duct should be 1,000 fpm.



Vibration Isolation

As indicated in the "Unit Design" section of this document, McQuay Vertical Self-Contained systems effectively isolate vibration from the fan section to the unit casing, and hence, the building. It is, however, necessary to resiliently support the unit outside the casing to prevent compressor vibration from reaching the building. This vibration is generally at very high frequencies and would be perceived as noise. For most office buildings, the unit is mounted on a concrete floor and would need only a double layer of one-inch waffle pads for vibration isolation. Pads should be sized for proper loading according to the manufacturer's rating.

Outside the unit, the condenser and/or chilled water pipes connecting to the unit should be resiliently supported with vibration isolators consistent with those used for the unit. Where double layer neoprene pads are used to isolate the unit, single layer neoprene pads or neoprene hangers can be used to support the connecting pipes and electrical conduit. Where spring isolators are used, spring floor mounts or hangers selected to achieve 0.75" deflection should be used.

In addition, condenser/chilled water pipe risers should be resiliently supported using neoprene isolators. The risers must not make contact as they pass through the floor structure. If a seal is necessary, lightly pack the space around the pipe with glass fiber insulation and seal it with silicone caulk.

Conclusion

As this application manual demonstrates, achieving a quiet tenant environment when using vertical self-contained systems, or any HVAC system, requires that you develop an acoustic solution in the design stages of the building project. Start with the equipment sound power, paying particular attention to the lower octave bands (63 and 125Hz) as these are the most difficult to attenuate. If the equipment is quiet to begin with, chances are the job will be quiet.

Once the equipment is chosen, the acoustic solution becomes a matter of proper MER location, size, and construction and good supply and return duct design. Your local McQuay representative is available to assist you with these details.

Definitions of Acoustic Terms

SOUND	Oscillation in pressure within an elastic or viscous medium (air) with resulting auditory sensation (audible to ear).
NOISE	Unwanted sound, subjective in nature.
DECIBEL (dB)	Ten (10) times the logarithm of the ratio of a given power to a reference power. In sound the current reference power is 10^{-12} watts or 1 pico Watt (Pw). Decibel dB: d (lower case) B (capital, after Alexander Graham Bell).
SOUND POWER LEVEL	$L_w = 10\log_{10} \frac{\text{Sound power emitted in watts}}{10^{12} \text{ watts}}$ L_w is used for describing the amount of sound emitted by a noise source.
SOUND PRESSURE LEVEL (dB)	$L_p = 20\log_{10} \frac{\text{Sound pressure level measured in microbars}}{\text{0002 microbars}}$ L_p is what is heard by the ear or measured by a microphone.
LOUDNESS	Human physical response to sound pressure--subjective in nature.
FREQUENCY	Number of oscillations per unit of time usually expressed in cycles per second, Hertz (Hz).
WAVE LENGTH (l)	Length of sound wave for one cycle of compression and expansion, in dry air, at sea level, wave length (ft.) = $\frac{\text{Speed of Sound}}{\text{Frequency}} = \frac{\text{1130fps}}{\text{Frequency}}$
_ WAVE LENGTH	Point of maximum pressure or motion in molecules of medium (air).
PURE TONE	Sound with a single frequency.
RESONANCE	Forced oscillation when the natural vibration frequency of the body is equal to the driving force frequency.
STANDING WAVE	Phenomenon resulting from a pure tone sound having a wavelength equal to a multiple of the distance between two reflecting walls causing difficulty in accurate measurement.
RANDOM SOUND	Sound with no consistent tone.
COMPLEX SOUND	Mixture of random sound and pure tones.
OCTAVE BAND	A range of frequencies where the mid frequency of one band is double the mid frequency of the next lower band. The octave band center frequency normally identified in HVAC are: Octave Band: 1, 2, 3, 4, 5, 6, 7, 8 Center of Frequency Range: 63, 125, 250, 500, 1000, 2000, 4000, 8000
NOISE CRITERION CURVE (NC)	A frequency plot which shows equally loud (subjective) sound pressure levels in different octave bands. The highest NC curve touched by a given sound's frequency plot is that sound's "NC level". This is the most commonly used criterion in the air conditioning industry.
SONES	A single number method to predict loudness levels, usually for small fans and ventilating equipment.
A, B, & C WEIGHTING	A method of electronic weighting within a sound meter to approximate human ear reaction. "A" scale is appropriate for low intensities, "B" for medium, and "C" for high intensity levels. It is used primarily for code specification and enforcement work, and is not appropriate for HVAC equipment rating.
REGENERATED SOUND	Sound generated by air turbulence within ductwork. It is similar to fan noise and increases with air velocity.
ATTENUATION	Reduction in sound power level as a sound travels through a duct or enclosure.
TRANSMISSION LOSS (TL)	The reduction in sound power level from one side of a wall to the other.
CEILING ATTENUATION FACTOR	The dB reduction in sound level, based on measurement between two contiguous rooms when the path is through the two ceilings and a plenum common to both. It is useful to evaluate sound transfer from one room to another through the ceiling plenum but not for calculating room sound levels from ceiling mounted equipment.
SOUND TRANSMISSION CLASS (STC)	The preferred single number rating designed to give a preliminary estimate of the sound insulating properties of a wall or enclosure.
SOUND ABSORPTION COEFFICIENT (A)	The fraction of randomly incident sound power absorbed or not otherwise reflected.
NOISE REDUCTION COEFFICIENT(NRC)	The arithmetic average of the sound absorption coefficients at 250, 500, 1000 and 2000 Hz. Used as an index of the noise reducing efficiency of materials.
ROOM EFFECT	Decibel difference between the sound power level emitted to a space and the sound pressure level measured at any point. It is a function of distance and the room environment.
ROOM CORRECTION	Decibel difference between NC in standard room and NC in an actual room. It equals the additional equipment sound power that can be tolerated due to more-than-typical sound absorption in a room, less-than-typical air quantity in a room or additional downstream duct sound attenuation.
SPEECH INTERFERENCE	Sound level usually in frequency range of 300 to 3000 Hz which interferes with speech intelligibility.
SPEECH INTERFERENCE LEVEL (SIL)	The dB average of the sound pressure levels in the three octave bands (4,5,6) with center frequencies of 500, 1000, and 2000 Hz.
MASKING	Process by which the threshold for intelligibility of one sound is raised by the presence of another (masking) sound. Speech is masked by sounds in "speech interference" frequencies.