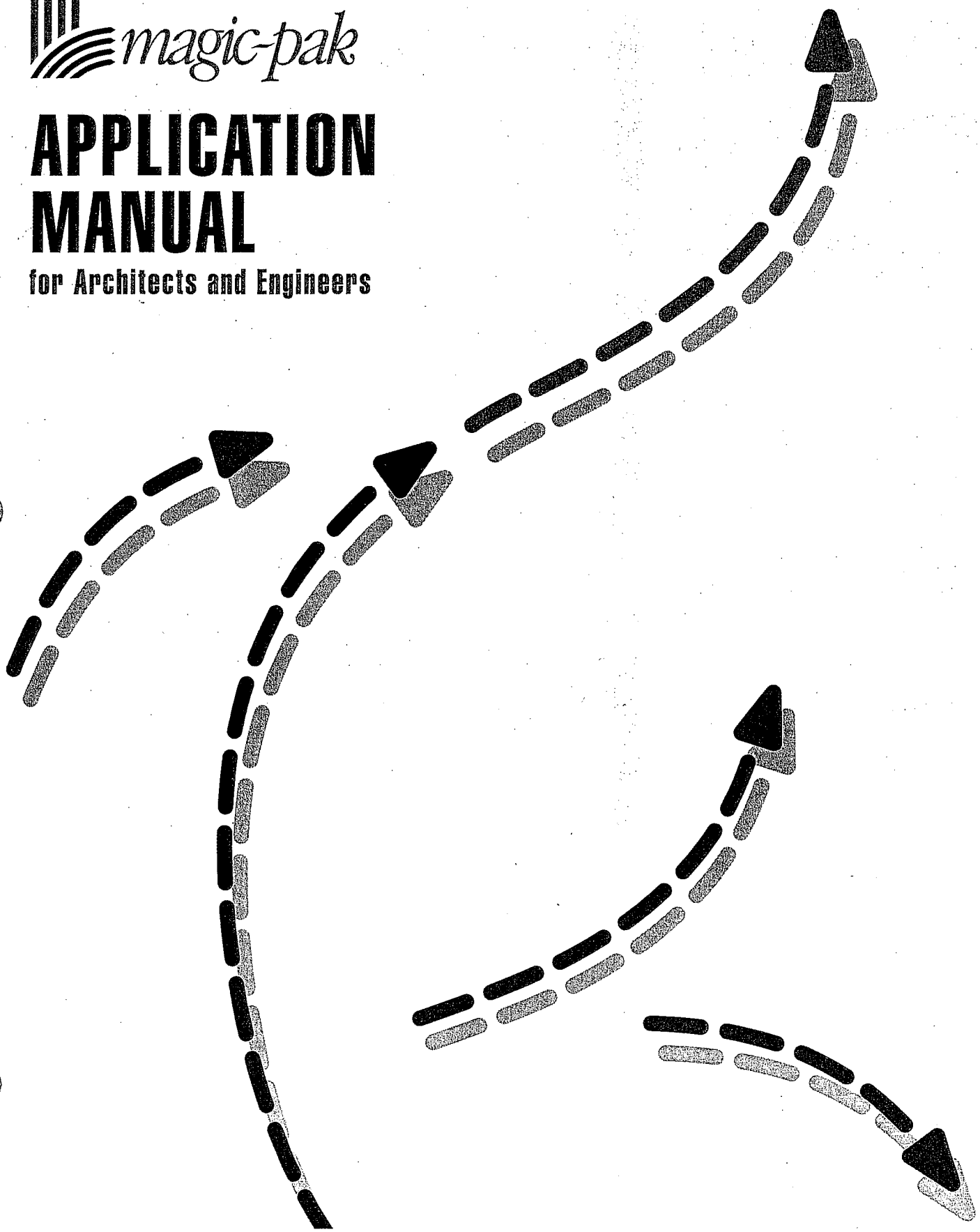
ARMSTRONG
Air Conditioning Inc.
A LENNOX International Inc. Company

magic-pak

APPLICATION MANUAL

for Architects and Engineers



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1. Purpose Of This Manual

This manual provides assistance to architects and design engineers who are considering the use of Magic-Pak heating and cooling equipment in multi-dwelling buildings or shopping centers.

It conveys some of the experience gained over many decades, and includes some of the most successful and economical installation practices for Magic-Pak units.

Building structure heat loss and heat gain, duct sizing, gas supply mains and riser sizing, and electrical-supply wiring should be determined for the building by a qualified Professional Engineer familiar with the applicable local building code requirements for the type of occupancy.

2. Magic-Pak: Designed And Built For Designers And Builders

For over 30 years, the Magic-Pak concept of providing quality heating and cooling in high-rise condominiums and apartment buildings has proven increasingly popular among building designers and mechanical contractors.

Over these years with literally hundreds of thousands of units installed throughout the United States and Canada, Armstrong has compiled comprehensive practical experience for varying types of building construction and operating conditions.

2.1. Totally Packaged HVAC System Provides Individual Comfort Control

The Magic-Pak concept provides all the practical benefits of a split system, plus a heating system, without the expense and complications of split-system units. Magic-Pak provides a ducted, single-package, combination heating-and-cooling unit for each individual suite that is reliable, easy to install and inexpensive to maintain. Just as important, it allows individual metering and comfort control for each unit.

Occupants can have heating or air conditioning any time of the year according to the outdoor temperature. A cold day in June, heating; a hot day in January, cooling. No central system has this flexibility.

2.2. Slide-Out Cooling Chassis

The slide-out cooling chassis is unique to Magic-Pak units and is a chief contributor to the ever-increasing popularity of the product. If service is required, any cooling chassis may be replaced with another in minutes. In fact, building maintenance personnel can easily perform this function without the refrigeration training or trade credentials often required to work on refrigeration systems.

2.3. Hermetically Sealed Refrigeration System

The hermetically sealed refrigeration system is another feature of the Magic-Pak's slide-out refrigeration chassis. The system is completely factory-built, checked for leaks with sensitive electronic equipment, and thoroughly performance tested before placement in any unit. This comprehensive testing eliminates the need for highly trained personnel at the time of installation or start up.

2.4. Interchangeable With Earlier Models

Another advantage of the slide-out chassis is the one that eliminates concerns of obsolescence. Replacement chassis are still available for units installed in the very first Magic-Pak buildings over 30 years ago. The chassis built today include modern technology in heat transfer surface and compressor design for higher efficiencies, but the chassis will still fit the older Magic-Pak models.

Dedication to this interchangeability with earlier models is basic to the Magic-Pak concept of today and insures that these units will never become "orphans" in the future.

2.5. Gas And Electric Alternatives

Magic-Pak offers a variety of heat sources to best suit the geographic area or local energy costs. All are ducted, through-the-wall units which have no need for chimneys.

• HWC — Gas Heating, Electric Cooling
Maximizes energy-cost efficiency in applications where gas is available. Uses only outside air for combustion. Built-in power vent eliminates need for chimney.

• PWC — Electric Heat Pump
The energy-efficient option for heating and cooling where gas is not available or preferred.

• EWC — Electric Heating, Electric Cooling
Provides the best alternative to a heat pump in all-electric applications.

3. Unit Location

Magic-Pak units should be installed in an outside building wall that is clear of obstructions which might impede the free intake and discharge of condenser air (Fig. 1).

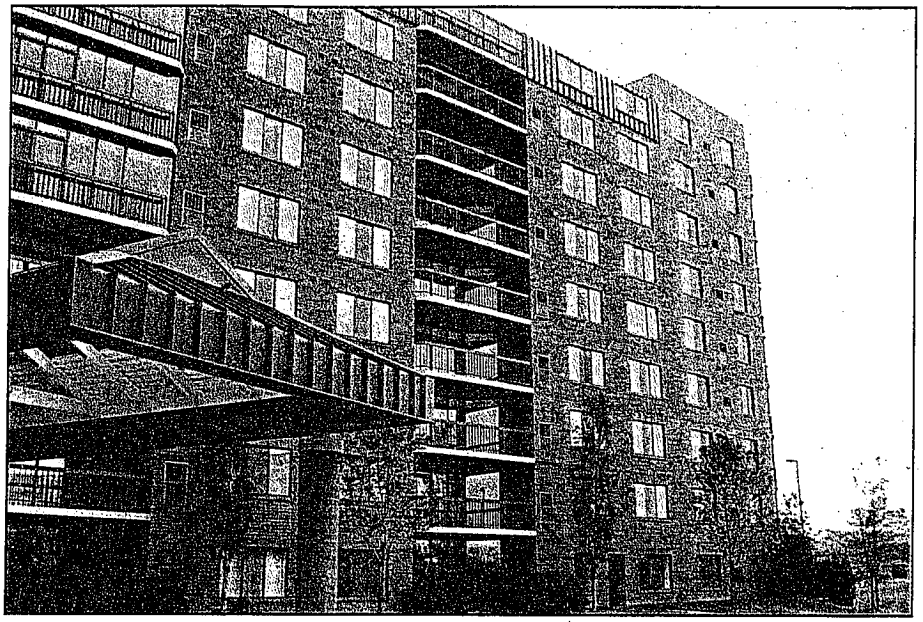


Figure 1 - Nine story luxury condominium with Magic-Paks on outside walls adjacent to balcony.

3.1. General Considerations

A building wall should be no closer to an opposite building wall than two feet for every floor or Magic-Pak unit in a vertical array facing the wall. For example, a one-story building with a Magic-Pak unit should be a minimum of 2 ft. from the wall facing the unit, and if the facing wall also has a Magic-Pak unit, the two walls should be at least 4 ft. apart.

A six-story building with six Magic-Pak units in a vertical array should be at least 12 ft. from the opposite building wall, and if that building wall also contains Magic-Pak units, the buildings should be at least 24 ft. apart.

Buildings taller than six stories need not exceed the separation needed for six-story buildings.

If three or more adjacent walls form an air shaft with Magic-Pak units facing each other in each wall, the separation between opposite walls should be increased by 20%.

These "rule-of-thumb" dimensions are intended to minimize possibilities for recirculation of condenser air, or interaction between units. However, these numbers are not exact for every application, and other considerations might suggest that the designer consult the factory about desired alternatives.

3.2. Sound Considerations

It should be mentioned that any time a hard surface or wall faces a unit, the sound emanating from that unit can be reflected by the opposite wall. If the two walls are not parallel, the sound may be somewhat dispersed, but in general it is preferable to locate Magic-Pak units in a wall with as much clear distance to the nearest wall or reflecting surface as is practical.

Units located in walls forming an air shaft or confined courtyard are not as desirable (from a sound standpoint) as units located in the outer perimeter walls of a building.

Similarly, if the unit is to be installed in a wall at right angles to a wall containing a window, at least 6 ft. of separation between the closest point of glass to the unit should be maintained in order to minimize sound transmission through the window.

If, however, such a location is unavoidable refer to the section on "Decorative Grilles and Facades" for suggestions on how others have succeeded in overcoming the challenges.

3.3. Accessibility

An important consideration when selecting a suitable location is accessibility for chassis removal.

A 30 in. wide minimum clear opening is needed in front of the unit in order to remove the chassis.

A 36 in. wide door or access covering to the enclosure is preferred as a minimum to allow for some tolerance in locating the access door frame exactly centered on the unit.

If the unit is located in the end of a clothes closet, and it is accepted that the clothes must be removed first to remove the chassis, be sure that the closet door is large enough to get the chassis out of the closet.

Also, if the Magic-Pak is installed through the side of a closet, be sure the closet is wide enough to permit sliding the chassis all the way out before running into the opposite closet wall.

The minimum distance to allow for chassis removal from the front of the unit cabinet to the opposite wall is:

PWC heat pump — 32 in.
Other models — 30 in.

(Note: There are special dollies available through wholesalers that can lean the platform from vertical to horizontal with an elevating-adjustment feature and four-wheel support.

These are very useful in close quarters to provide a platform to slide the chassis onto during removal and subsequent replacement of a chassis.)

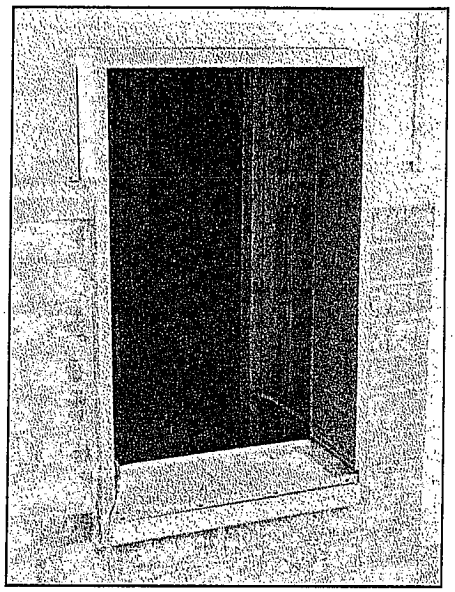
Units in a relatively inaccessible location for easy chassis removal should be avoided if at all possible — if for no other reason than to keep the air filter accessible for easy and timely cleaning by the occupants or by maintenance personnel.

3.4. Vent Location For Gas Models

Consideration for location must be given to the power vent of gas-fired Magic-Pak models such that they will not be installed at variance with the latest edition of the National Fuel Gas Code (NFPA 54/ANSI Z223.1).

4. Wall Sleeves

"Wall sleeve" is the term used to describe an accessory for the Magic-Pak units. The wall sleeve is designed to facilitate the installation of Magic-Pak units by providing an accurate opening during building construction. Units can then remain off-site until building construction approaches completion.



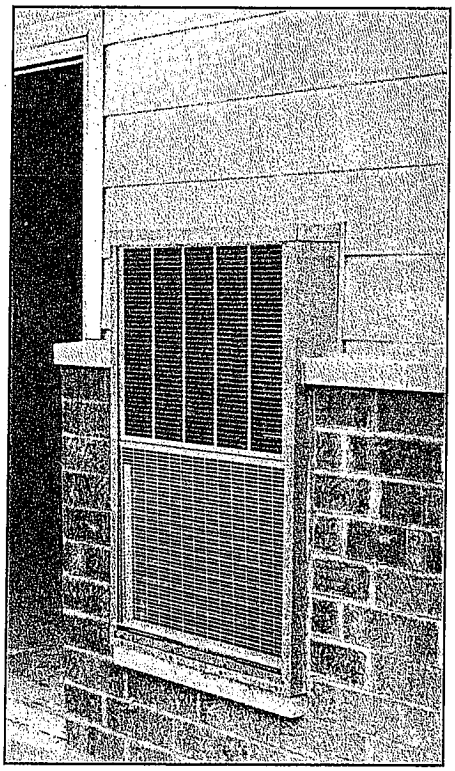


Figure 2 (top) and Figure 3 (right) - Wood frame construction with brick veneer tends to minimize vibration excitement of adjacent walls.

The wall sleeve is comprised of four assemblies (top, bottom, and right and left sides) which easily slip together on the job to form a rectangular box correctly sized to receive a Magic-Pak unit.

When in place and securely fastened, the wall sleeve opening provides easy access to the finished wall perimeter for caulk sealing.

Magic-Pak units may be installed without wall sleeves as long as the outside perimeter of the cabinet can be reached for caulk sealing against weather. Units installed in single-story building walls or in walls with a balcony on multistory buildings are an example. Otherwise, Armstrong recommends that a wall sleeve be fastened into the wall opening and caulk sealed around the outside perimeter at the building wall (Fig. 2).

In multistory buildings, weather sealing may be done by access through the opening in the wall sleeve later to be filled by the Magic-Pak unit.

The weather-seal caulking is easier to perform when the sleeve protrudes beyond the finished wall by 3/8 in. to 1 in. (Figs. 2 and 3).

4.1. Installation

The sleeve may extend farther than 1 in. beyond the finished wall, but reaching the perimeter of the opening from inside for sealing becomes increasingly difficult (Figs. 4 and 5).

In any case, one needs to consider adequate safety precautions to protect personnel.

In many high-rise construction applications, contractors insert the wall sleeves from the outside while the wall is being constructed (Figs. 6, 7 and 8). The two-sided support angles furnished with the wall-sleeve kit should then be attached to the wall-sleeve sides at a location that will exceed the thickness of the outside finish wall by the recommended 3/8 in. to 1 in. dimension.

For example, if the supporting wall is concrete block with a brick facing, there is usually a space between the block and the brick. This space dimension must be added to the width of the brick (plus 3/8 in. to 1 in.) so that — when the sleeve is inserted into the block-wall opening, up to the angles, and fastened to the block wall before the brick is installed — the sleeve will protrude beyond the finished brick by 3/8 in. to 1 in., as needed for caulk sealing (Fig. 9).

The same applies if the supporting wall is wood-frame. One may insert the sleeve from the outside up to the angles located on each side, allowing for the thickness of sheathing, finish siding, and caulk sealing.

In any case, the wall sleeve must be fastened to the supporting wall and not to the finished wall.

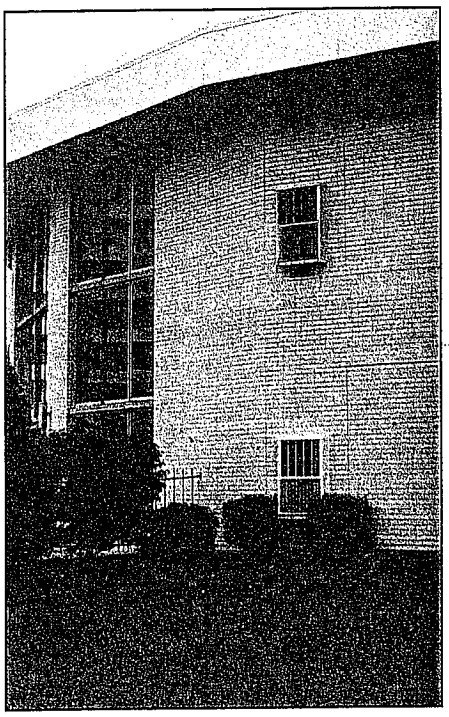


Figure 4 - Mounting through the wall up to the Magic-Pak mounting flange inside permits minimum intrusion into interior occupied space of 13-7/16 in.

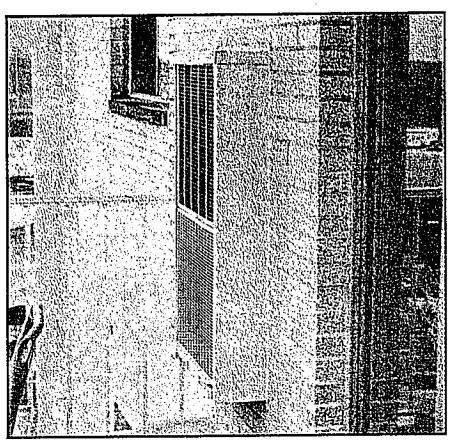


Figure 5 - Unit located near reinforced door or window opening and through brick-veneer wall reduces likelihood of vibration excitement of wall in wood-frame construtions.

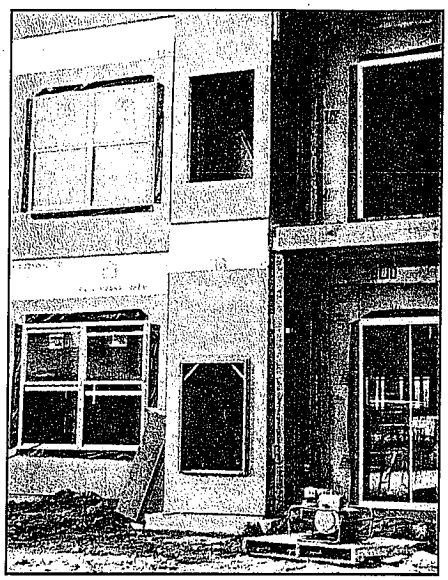


Figure 6 - Wall sleeve installed from outside.

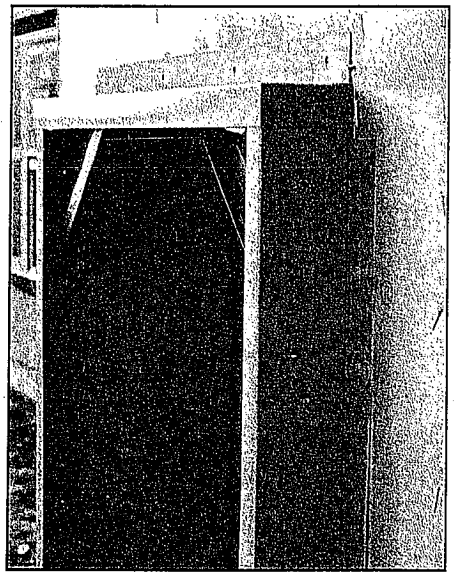


Figure 7- Wall sleeve installed from outside.

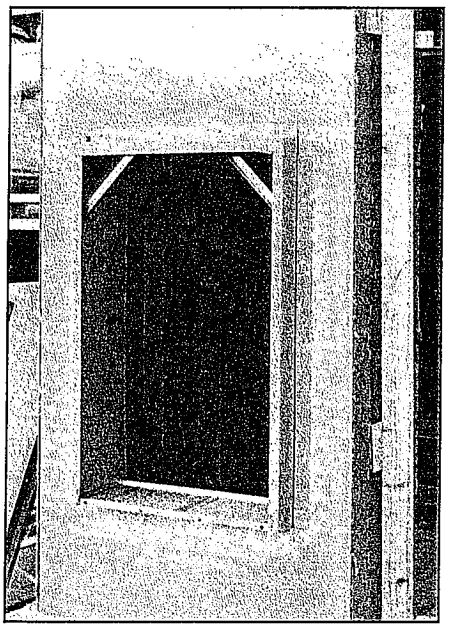


Figure 8 - Wall sleeve installed from outside.

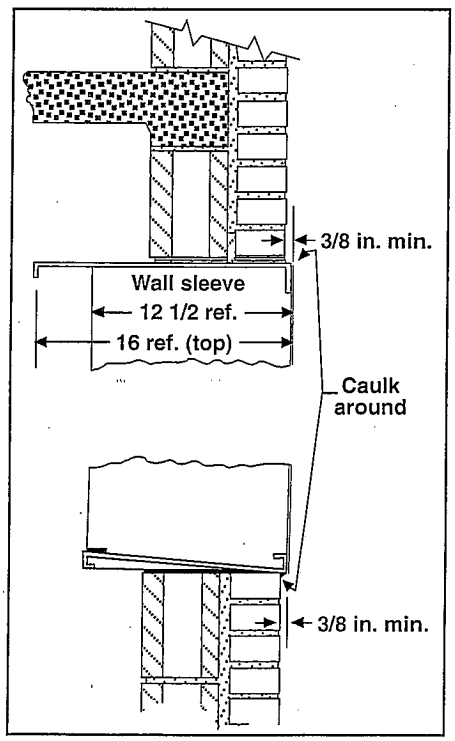


Figure 9

Some builders will attach through the side support angles to the support wall whether inserting the sleeve from the outside or inside. Others will use the side angles simply as a locating "stop" to achieve the appropriate dimension while shooting fasteners through the sides of the wall sleeve into the supporting wall (Fig. 10).

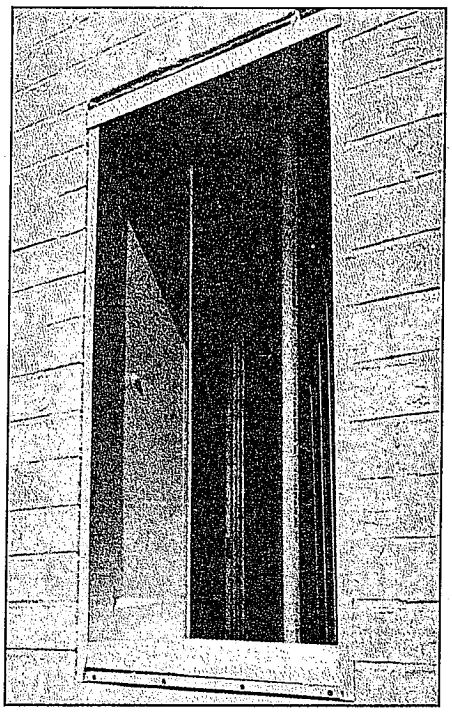


Figure 10 - Fasteners shot through wall sleeve sides into block wall.

The most popular method of installing the wall sleeve is from the inside of the building with the weather seal applied from the outside as the finish wall is applied.

4.2. Recessed Sleeves

In some applications, where building walls are very thick (over 16 in.) or architectural design dictates, units can be recessed. One should avoid recessing the wall sleeve (or Magic-Pak without wall sleeve) if the wall opening is required to be the same as the wall-sleeve opening. However, if the wall opening can be larger in vertical dimension than the wall sleeve, so that the bottom can rest on a sill that is at least 2 in. higher than the bottom of the wall opening, some recessing is permitted (Figs. 11 and 12).

This sill should be recessed further than the sleeve by 3/8 in. to 1 in. to permit weather-seal caulking along the bottom edge without plugging the drain holes in the sleeve or the unit installed without a sleeve. See Fig. 21.

The top of the wall opening should be above the top of the wall sleeve by a dimension equal to or greater than the amount of the recess to avoid restriction of the condenser discharge air.

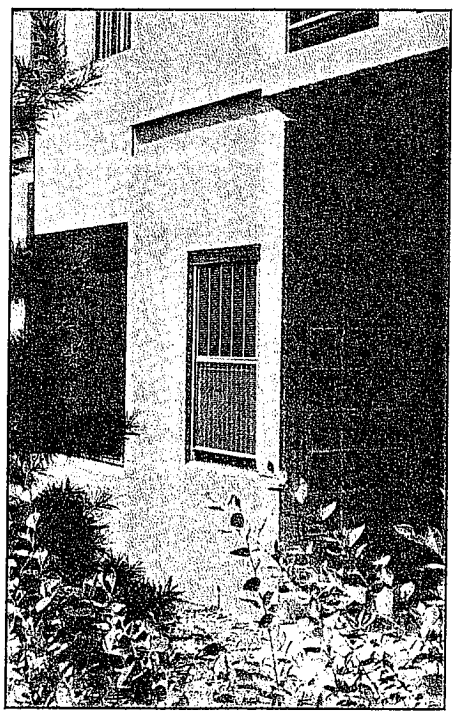


Figure 11 - Recessed wall sleeve with enlarged and tapered-edge opening

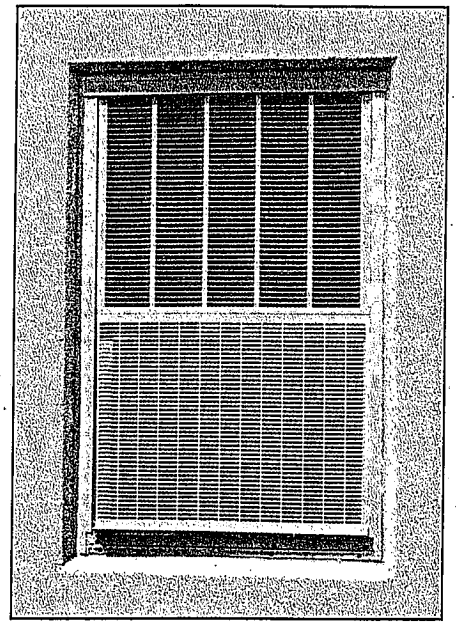


Figure 12 - Recessed wall sleeve with enlarged and tapered-edge opening

4.3. Weather-Proofing Wall Sleeves

Wall sleeves are packaged one to a carton and are shipped flat to save space and shipping costs. They snap together easily at the job site and are held square (until ready to receive a Magic-Pak) by two braces fastened inside the top corners. Instructions for caulk sealing the slip joints and spot-welded joints have been added to minimize problems with water infiltration during episodes of high wind-driven rain.

This sealing must be done after the wall sleeve is assembled, but before the Magic-Pak unit is installed in the sleeve. Caulk sealing of the bottom is best accomplished right after the wall sleeve is assembled but before it is placed in the wall opening (Fig. 13). Remaining final sealing can be done just after the sleeve is secured into the wall opening, if desired, to avoid breaking the seal during handling (Fig. 14).

Further sealing against air infiltration must be done after the Magic-Pak unit is installed in the wall sleeve and utility connections are completed. For additional protection, the space between the unit and the wall sleeve should be sealed on all sides with a bead of sealant (Figs. 15 and 33).

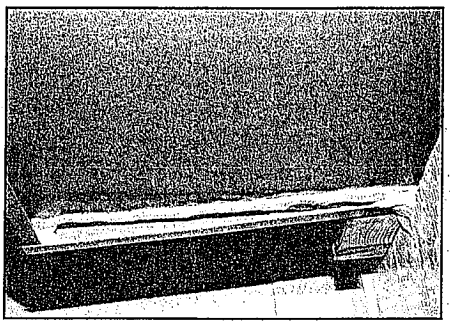


Figure 13 - Caulk seal outside joints of wall sleeve before inserting into wall opening. (Underside view of wall sleeve bottom.)

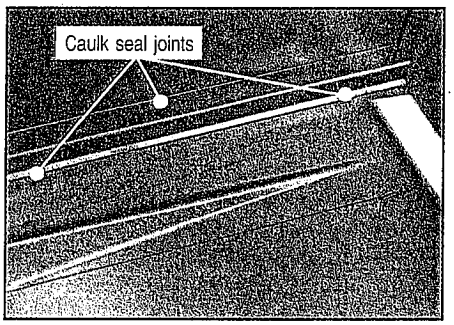


Figure 14 - Caulk seal outside joints of wall sleeve before inserting into wall opening.

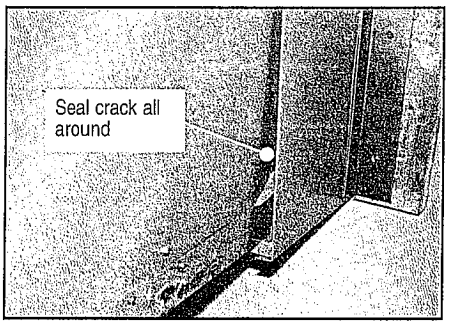


Figure 15 - For additional protection against air infiltration during periods of very high winds, fill the clearance space between unit and wall sleeve all around with sealant.

5. Types of Wall Constructions

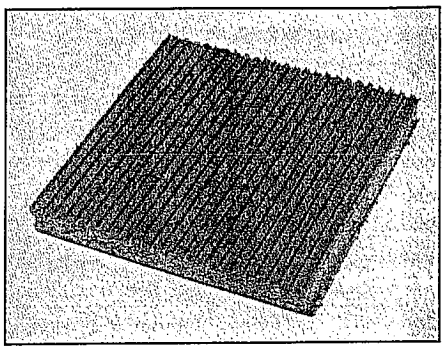


Figure 16 - Vibration Isolation pad.

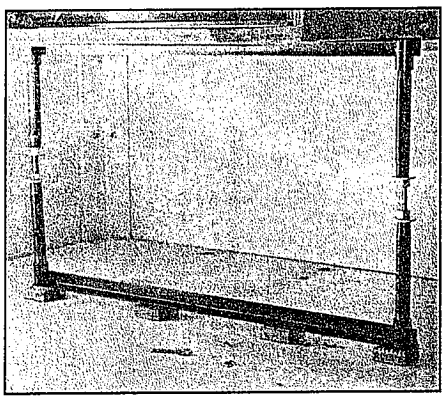


Figure 17 - Photo of support under unit with vibration pads in place.

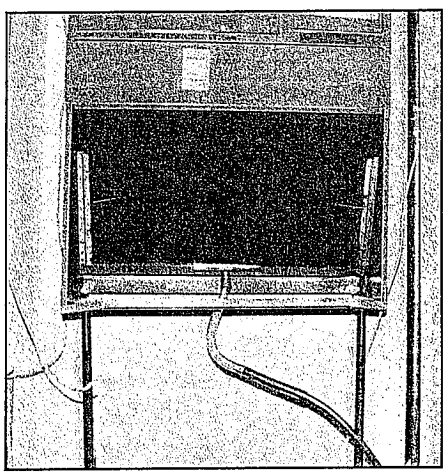


Figure 18 - Condensate-tube exit holes improperly used to attach support legs. Bottom of unit has become distorted as a result. Not recommended.

5.1. Support

In general, the wall sleeves will support the Magic-Pak units on any wall. The wall, however, must be adequate to support the unit. Otherwise, one must provide additional support between the unit and the floor. The center of gravity is between the bottom return-air opening rear flange and the wall sleeve. When additional support for the unit is desirable, it should be near this center of gravity and applied evenly across the bottom of the unit through adjustable legs to the floor.

A supplementary support can be made for this purpose. It consists of two steel channels, 28 in. long, one placed under the unit and one on the floor. They are separated by 3/4 in. pipe and "all-thread" rod, with nuts and washers, to provide the adjustment pressure (Fig. 17). Vibration-isolation blocks are also required to minimize transmission of vibration into the floor (Figs. 16 and 17).

Even though the wall may be adequate to support the unit, experience has shown the desirability of supplementary support as described above, reducing the possibility of vibration transmitted into the wall and to other parts of the structure.

Two 1 in. diameter holes are located near the front of the Magic-Pak on either side of the return-air opening. These holes are intended to allow a condensate drain tube to exit the return-air duct cavity whenever a closed return duct and flexible collar are used. These should not be used to support the unit. The sheet metal cabinet in this area is not heavy enough to act as a support without distorting and interfering with proper retention of the filter access cover (Fig. 18).

5.2. Wood-Frame Walls

The framed opening should consist of double two-by-fours or two-by-sixes on both sides and across the bottom of the opening, with at least one vertical support under the center of the opening (Fig. 19).

If the wall sleeve is inserted from the inside, the unit can be amply supported by lag screws inserted into the double two-by-fours through the side mounting angles on both sides of the wall sleeve. However, the angle must seat against solid wood all the way up and down, not against any dry wall or soft wall board which might dis-integrate under conditions of prolonged pressure or vibration.

If the wall sleeve is inserted from outside, the same concerns apply. The mounting angles should seat against solid wood studs or plywood sheathing, not against soft insulating sheathing.

Most wood-frame stud walls are strong enough to support the Magic-Pak unit, and in many cases are more effective than concrete walls in reducing vibration frequencies carried from one floor to another. However, the remainder of the wall construction and its rigidity is the controlling factor for vibration control.

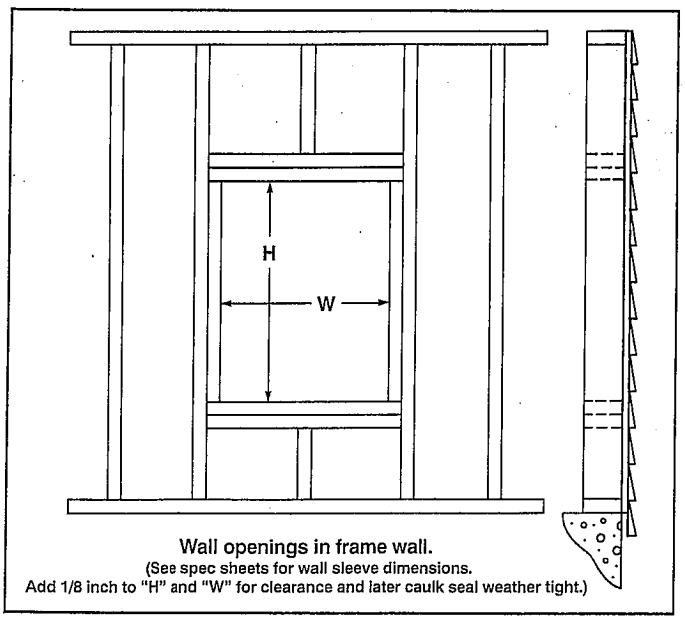
A light weight wall with little or no insulation, thin interior dry wall, and exterior sheathing can be excited by vibrating machinery and will transmit the vibration more easily into other areas. As a precaution against this possibility, it is recommended that vibration pads be placed in the bottom outside edge of the wall sleeve before the Magic-Pak is inserted into the wall sleeve.

Further, a supplementary support should be used, consisting of transverse support channels located near the center of gravity and isolated with four vibration pads between the upper channel and the bottom of the Magic-Pak, in addition to four vibration pads located between the lower channel and the floor (Fig. 17).

Lifting the weight of the unit is achieved by turning the nuts on the threaded legs of the supplementary support sufficiently to transfer the unit weight to the vibration pads on the floor, but not so much that the unit is lifted completely off of the weather-seal gasket located between the wall-sleeve bottom and the unit bottom.

Some pressure should remain on the gasket to provide a weather seal.

Also, the wall-sleeve-to-unit vertical gaskets on the outdoor side should still seat against the unit all the way from top to bottom and not be opened up near the bottom by too much lift pressure from the jack screws.



Wall openings in frame wall.
(See spec sheets for wall sleeve dimensions.
Add 1/8 inch to "H" and "W" for clearance and later caulk seal weather tight.)

Figure 19 - Line drawing of frame wall with opening braced for wall sleeve attachment.

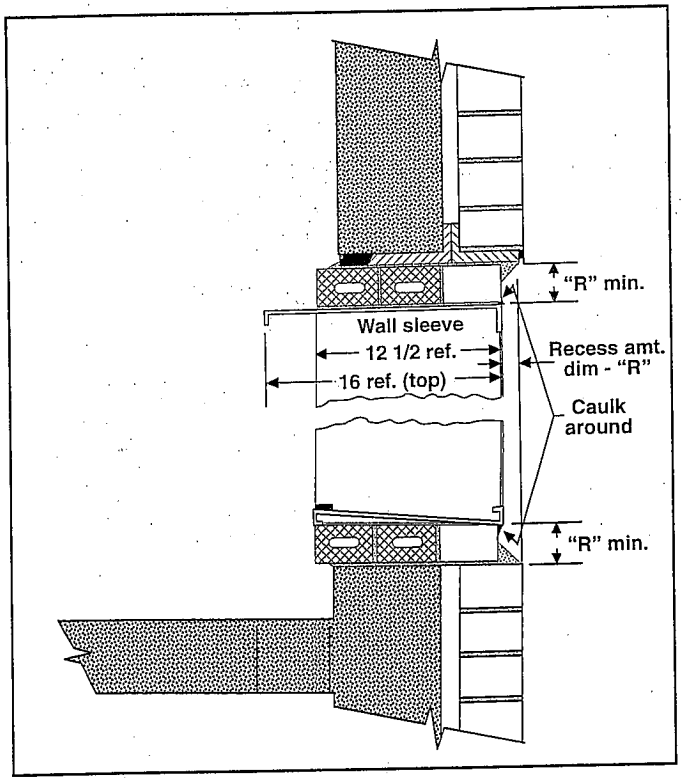


Figure 21

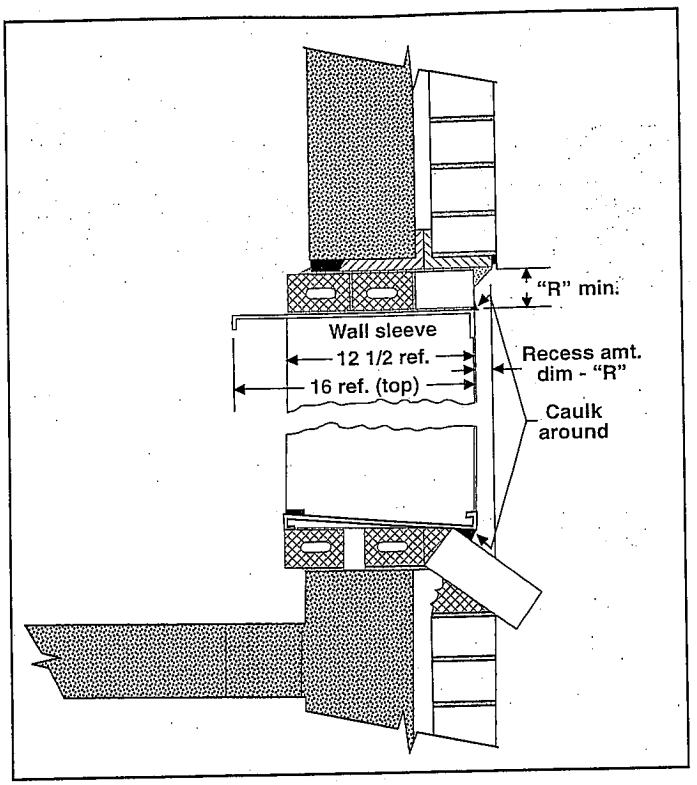


Figure 22

Additional isolation can be achieved by the use of rubber grommets between the top support angle on the Magic-Pak and the corresponding top turn down retaining angle on the wall sleeve (Fig. 20).

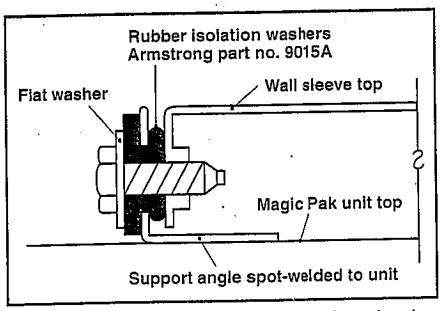


Figure 20 - Enlarged cross-sectional view showing support angle at top of wall sleeve, highlighting rubber isolation grommets.

It is recommended that these precautions against vibration be included unless the designer is certain that the wood-frame wall will be rigid and well-packed with insulation when completed.

5.3. Cement-Block Walls

Cement-block or cinder-block walls have proved to be the most forgiving for vibration and noise transmission in single or multi-story buildings.

Wall sleeve openings must include a suitable lintel across the top as prescribed by local building codes.

The wall sleeves may be installed from inside or outside of the building and this choice will determine the location of the side angles.

Many contractors prefer to shoot fasteners through the sides of the sleeves into the block, using the side angles as position locators.

It is important that the angles be held tightly to the block along both sides while shooting the fasteners in order for the wall sleeve to finish vertical.

Either 8 in. or 12 in. block will accommodate the wall sleeve. The wall-sleeve sides are 12-1/2 in. for 8 in. block, plus 4 in. brick facing.

The top supporting angle on the Magic-Pak is 16 in. from the outside grille face. Therefore, 12 in. block plus 4 in. brick would not permit enough protrusion to permit caulking across the bottom edge without risking plugged drain holes. In this case, the vertical dimension of the opening should be made larger by 1 in. to 2 in. to permit the use of a recessed sill on which wall sleeve can rest and still provide a means to caulk seal across the bottom without obstructing the drain holes (Fig. 21).

When the outside facing is brick, another approach has been to keep the block-wall opening the same for the wall sleeve; but the direction of the brick placed along the bottom is changed. The long dimension is placed at an angle starting underneath the wall sleeve by 1/2 inch or more, sloping downward to permit drainage, while still

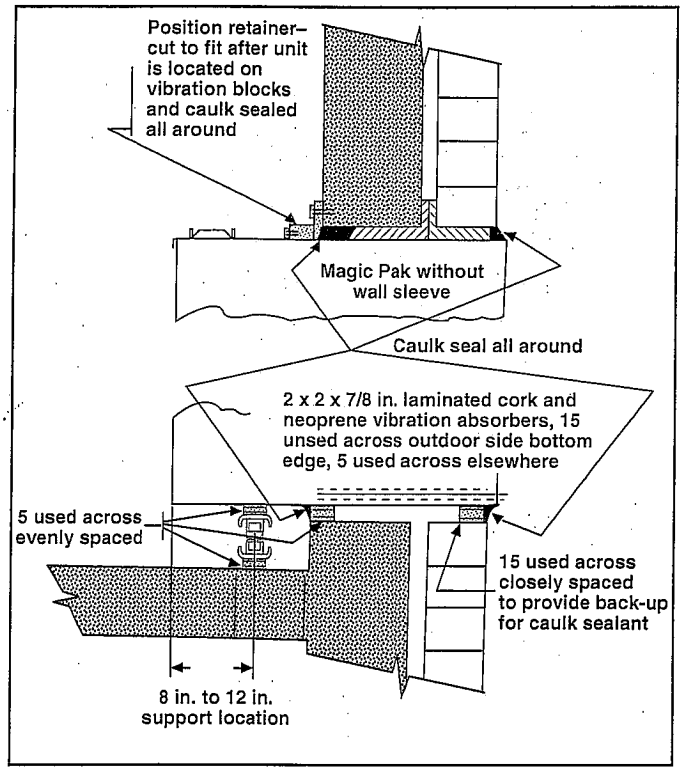


Figure 23

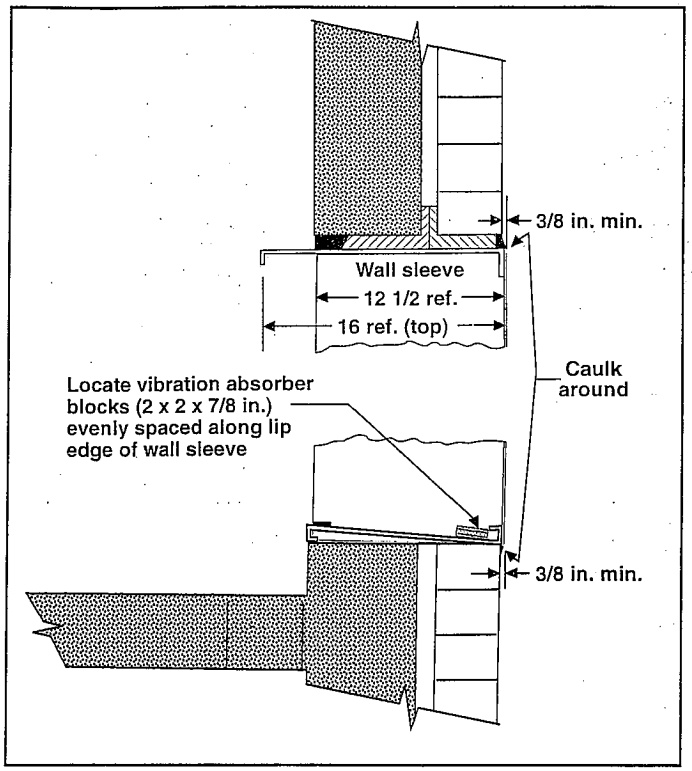


Figure 24

providing a suitable groove between the sleeve and brick in which to apply caulking material.

This can also work when recessing the sleeve, up to 2 in., even if the total wall thickness is not excessive (Fig. 22).

5.4. Poured-Concrete Walls

The use of "pre-cast" or poured-concrete walls has increased considerably in high-rise, multistory building construction. These buildings require special consideration to isolate vibration. When used in conjunction with prestressed con-crete floors, noise phenomena can occur several floors away or on an opposite side of the building. Curing these phenomena usually means isolating the unit from the wall, as well as from the floor.

If no wall sleeve is used, vibration blocks should be placed along the outside bottom edge to carry the weight of the unit and act as a stop for caulk sealant along the bottom edge (Fig. 23).

If a wall sleeve is used, vibration elimination blocks should be placed inside the bottom of the wall sleeve before the Magic-Pak unit is inserted into the wall sleeve (Fig. 24).

In either of these cases, a supplementary support should be included to isolate any vibration from the floor (Fig. 23).

5.5. Metal Studs

Some types of construction involve the use of steel 2 in. x 4 in. channel studs in exterior walls, covered with a rigid sheathing and thick, rigid insulation panels with extensive use of adhesives. Magic-Pak wall sleeves are attached to the steel studding just as for wood, except that self-drilling screws are used with power drivers (Fig. 25).

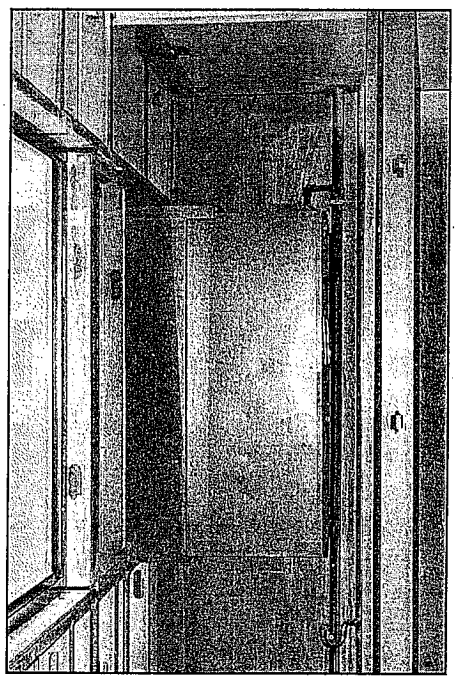


Figure 25 -Wall sleeve fastened to steel 2 in. x 4 in. studs with screw fasteners shot through sides of wall sleeve.

6. Noise Transmission

Noise perception by building occupants can be an elusive, and early planning can address many adverse contributing factors.

For duct layout and air distribution it is better to locate a unit centrally in the floor plan. If it can also be a utility-room, kitchen or balcony location, as opposed to a bedroom or living-room location, then both ductwork and sound-transmission concerns can be better served. If the floor plan does not permit the best of both worlds, there are other ways to reduce the noise perception in occupied rooms adjacent to the Magic-Pak units.

In general, the perception of noise can be traced to:

1) *vibration transmission*
2) *sound radiating from the source (compressor and motors) through the panels and enclosure walls*
3) *air noise*
4) *resonant surfaces and objects*

6.1. Vibration Transmission

In spite of the efforts of rubber mounting, balancing, flexible loops of tubing and mufflers, there is always some vibration created by moving machinery, and a Magic-Pak unit is no exception. If the remaining vibration can be absorbed by the wall which supports the unit without transmitting the energy further or exciting an adjacent structural member, there is no problem. Otherwise, Armstrong recommends additional vibration isolation using vibration pads between support stands and the floor (Figs. 17, 23 and 24), as well as between the unit and the bottom of the wall sleeve (Fig. 24).

Concrete block walls have proved to absorb vibration better than poured-concrete walls.

Wood stud wall construction can be more easily excited to re-radiate vibration unless adequately dampened by other materials.

Wood stud walls which are heavily packed with fiberglass batt insulation or rock wool are less likely to re-radiate vibration than are sparsely insulated (or un-insulated walls).

Flexible duct collars must be used between the Magic-Pak plenum duct flanges and any sheet metal ducts. Also, the ducts must not be supported by, or otherwise touch, the unit.

6.2. Radiated Sound And Resonant Surfaces Or Objects

In general, the sources of sound are the compressor and the rotating motors incorporating air moving blades. A 60 Hz AC power hum can sometimes be heard from these sources or the control transformer, but generally this is imperceptible in a normal operating unit and does not contribute to any sound problem. The sound frequencies generated by the motor/compressor acting upon the refrigerant gas are a substantial contributor to the total sound radiated by the unit.

Sound frequencies generated by the action of the blades of the circulating air blower and the condenser fan blade upon air are additional sources of radiated sound.

Frequently these sources of sound can transfer certain frequencies to other objects or surfaces which might in turn be resonant with some of the frequencies from these sources of sound. If this is the case, these objects or surfaces can be excited to vibrate and further impose the sound on another area.

These sound sources then radiate to enclosing panels, which are made of materials that either reflect, absorb or transmit (usually a combination of all three) certain frequencies.

Some types of materials are more "transparent" to some frequencies than others. Factors that affect this property include thickness, density and distance from the source. A closet enclosure for the Magic-Pak unit can reduce the sound level in the adjoining space if constructed with this purpose in mind.

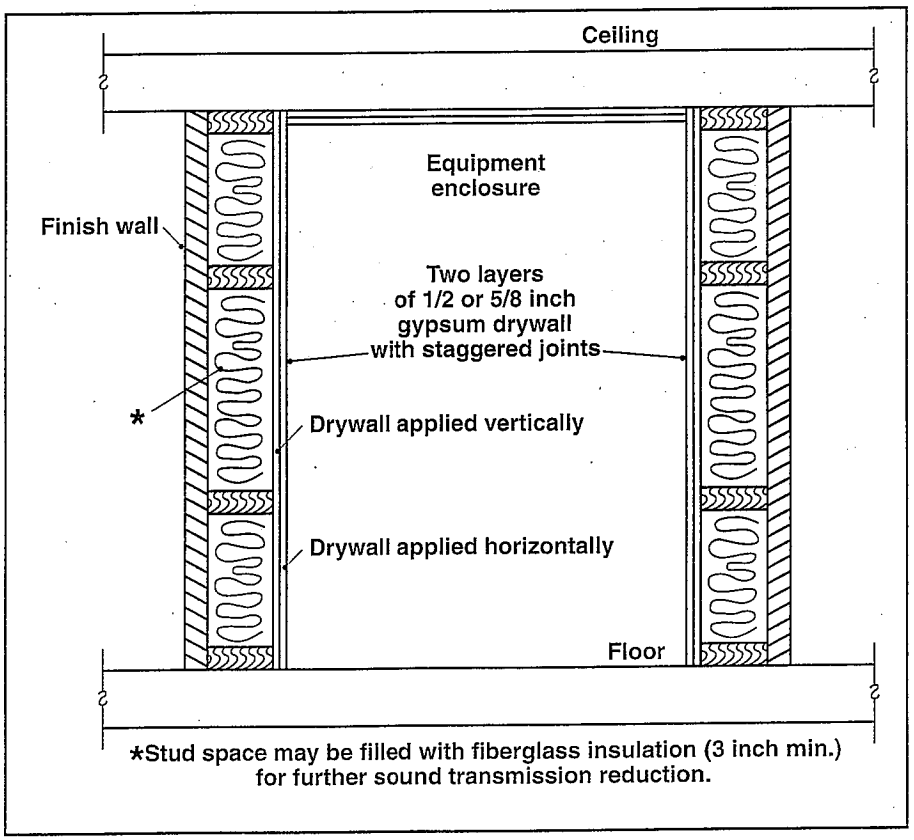


Figure 26 - Line-drawing elevation cross section of closet enclosure showing two (2) layers of gypsum dry wall applied to side walls and ceiling.

6.3. Clearances

The Magic-Pak cabinet is approved for "zero" clearances, as far as safety codes are concerned. However, if sound transmission through a wall is of major concern, a minimum dimension of 4 in. to the inside wall surface is preferred. This applies also to the front access door of the closet. Additional sound attenuation can be achieved by using two layers of gypsum dry wall (5/8 in. or 1/2 in. minimum) on the inside (Magic-Pak unit side) of the walls and the front access door of the closet (Fig. 26).

The side walls can further be improved for sound transmission if the 2 in. x 4 in. studs are fastened to 2 in. x 6 in. top and bottom plates and staggered to opposite edges of the plates on 16 in. centers. This forms a nominal 6 in. partition wall instead of the usual 4 in. wall, and permits the inside wall board and outside wall board to be fastened to studs without being tied together to the same stud. The space between the two wall surfaces may then be filled with 2-1/2 in. minimum, 1-1/2 pound density fiberglass (Fig. 27).

This same type of staggered stud wall construction may effectively be used as return-air space, where local building codes permit.

Cement-block construction for the side walls of the closet enclosure has been employed successfully using a minimum thickness of 4 in. block to attenuate radiated sound. The effectiveness is further improved by adding two layers of gypsum wall board fastened to the inside wall surface by means of furring strips and structural adhesive (and/or nails).

Fiberglass or rigid polystyrene insulation may be applied between the furring strips if thermal insulation and a vapor barrier is appropriate in the building design. However, the fiberglass or polystyrene alone will not prove effective at these frequencies without two thicknesses of gypsum wall board, unless the fiberglass thickness is increased to more than 3 in.

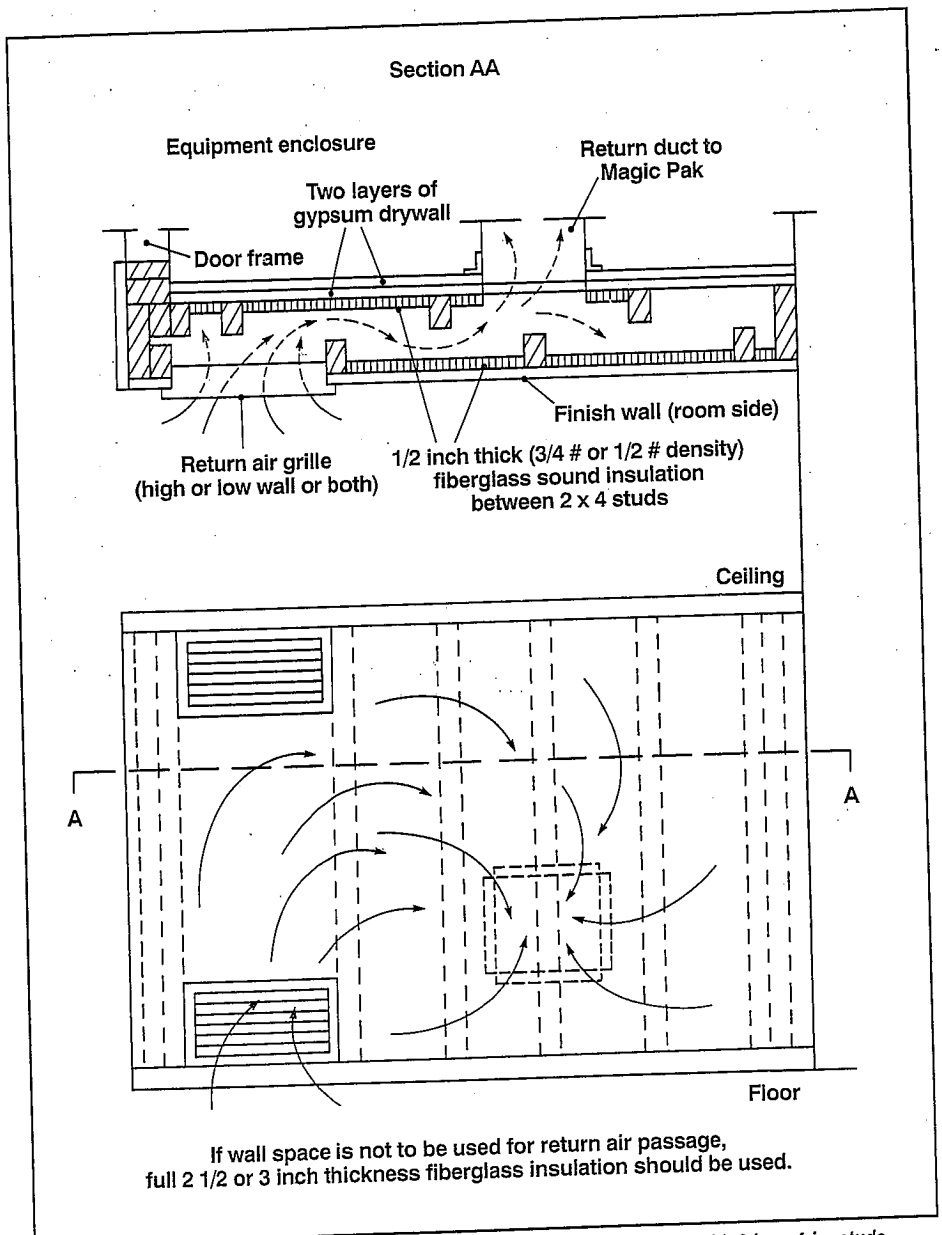


Figure 27 - Line drawings, plan and elevation showing cross section of walls with 2 in. x 4 in. studs staggered on wide top and bottom plate for lateral air passage.

6.4. Determination Of Sound Rating Values

The sound rating numbers which are listed in the ARI Directory and are certified by manufacturers of unitary equipment under ARI Standard 270-95 have little or nothing to do with the perceived sound characteristics of the indoor space served by the unit. These sound rating numbers (in decibels) are only useful in working with sound levels and measurements at locations outdoors and distant from the unit, such as a property line or an apartment across the courtyard.

ARI Standard 275-84 describes how to apply the sound ratings. This serves a very useful purpose when dealing with sound ordinances and local code requirements during design and planning stages, when landscaping elements and building orientations can still be adjusted. ARI 275-84 allows one to predict sound levels at various locations, and it provides various methods for changing these levels.

The sound levels inside the space being served by a unit have not been as thoroughly addressed by the industry in the form of an ARI standard.

Some local building codes have indoor requirements stated in terms of A-Weighted Sound Level (dBa), Noise Criteria (NC) Curves or Room Criteria (RC) Curves.

The 1995 Applications Handbook published by ASHRAE provides a means of calculating NC ratings, in Chapter 43, Sound and Vibration Control.

The values of sound power level for the octave band center frequency of 63,125,250,500,1000,2000, and 4000 Hz are shown in Fig. 28 for Magic-Pak models. These values can be used to calculate NC ratings as described in the 1995 ASHRAE Applications Handbook.

6.5. Air Noise

6.5.1. Supply-Air Duct System

Duct air velocity, air turning corners, changes in duct size, etc., can all create sound of a much different character than the vibration and radiated sounds of moving machinery. Since Magic-Pak units are usually connected to ducts for air distribution, any air noise will usually be heard at the supply registers or return-air grille in the room.

Supply ducts and the plenum on the Magic-Pak unit should be insulated to prevent condensation formation on the outside of the duct during summer operation. If the insulation is applied to the inside of the ductwork when it is made, the dual purpose of insulation and sound reduction will have been achieved.

As well, the use of 1 in. thick fiberglass duct board will accomplish the same where local codes will permit.

A supply register cut into the side of the supply plenum or at the end of a very short duct is not recommended. At least 4 ft. of inside insulated duct and/or at least one turn of direction is needed to attenuate the noise in the duct or plenum.

The face velocity of air out of the supply register will ultimately determine the perception of sound from air noise.

The selection tables furnished by the register manufacturer usually include values for noise along with face velocity, throw and air friction at the required air flow for each supply register.

6.5.2. Return-Air Duct System

More frequently, air noise involves the return-air system (or lack of it) when a return grille is simply cut into the side or the door of the closet enclosing the Magic-Pak unit. This is not recommended, since any equipment operating noise or air velocity noise in the closet can escape through the return grille unimpeded (Fig. 29).

This practice also frequently utilizes the closet space as a return plenum for air returning to the Magic-Pak unit and presents additional disadvantages discussed later.

If only one return-air grille is used, it should not be in "line of sight" to the closet enclosure or the return duct opening in the bottom of the Magic-Pak unit.

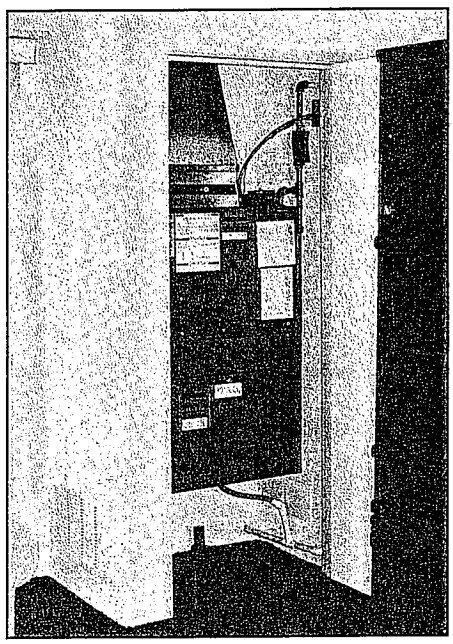


Figure 29 - Return grille with direct opening into equipment room allows sound to escape into living area and should be avoided. Also note lack of unit support at bottom.

Magic-Pak indoor sound power levels during cooling operation with compressor, condenser fan motor, and indoor blower motor on highest speed.

Octave Band Center Frequency	Magic-Pak Indoor Sound Power Levels
Hz	dB re 1pW
63	79.2 dB +
125	84.0 dB +
250	74.5 dB +
500	68.5 dB +
1000	67.0 dB +
2000	65.5 dB +
4000	62.5 dB +

Figure 28

Offsetting the grille location up or sideways in a 6 in. closet side wall is one method used successfully (Fig. 27).

Additional air-noise attenuation can be accomplished by adding 1/2 in. thick duct liner to the air passages thus created, and to the inside surface of the opposite wall facing the return grille (Fig. 27).

If the closet enclosing the Magic-Pak is used as a return-air plenum and the return-air grille is located in one of the enclosing walls directly adjacent to the unit, the grille should be located high on the wall, rather than at floor level. Then duct liner can be placed on the inside closet walls and door to effectively reduce the air noise from the bottom of the unit. This high wall location has the advantage of minimizing "roll out" of infiltration air during high-wind conditions (Fig. 27).

If other considerations dictate that a low wall return grille should be used, the air passage should be "trapped" inside the closet with a vertical duct 4 ft. to 5 ft. high, open at the top, 4 in. deep and as wide as the grille, with duct liner (1/2 in. thick) applied to the inside duct surface. Rigid duct board may also be used where local codes permit (Fig. 27). This will reduce the airborne sound at the return grille and is also effective against cold air "roll out" due to infiltration in high-wind conditions.

Another treatment for air-noise reduction on the return-air side is to drop a short duct down through the return-air opening of the Magic-Pak to within 6 in. to 8 in. of the floor. The filter access door must first be removed in order to reach the opening. This short duct must also be lined inside with 1/2 in. duct liner.

A second piece of sheet metal (about 30 in. x 30 in.) with duct liner on one side should be placed on the floor directly under the return-air duct with the insulated side up. A piece of thick pile carpet directly beneath this short duct will serve the same purpose.

If the return grille is <u>low</u> in the sidewall or closet door, the effect of infiltration in high-wind conditions may still be noticeable due to "roll out" if the circulating blower is off and the room thermostat is satisfied.

Since most of the infiltration comes through the wall sleeve and not through the Magic-Pak unit, it is recommended that the closet enclosure <u>not</u> be used as a return-air plenum. Instead, connect the return grille (or duct) directly to the return duct flanges on the Magic-Pak unit using sheet metal ducts lined with fiberglass insulation or duct liner and a flexible collar connector between the unit and the metal ductwork (Fig. 30).

The practices just described are intended to deal primarily with air noise and airborne sound, as well as vibration and radiated sound.

Infiltration will be discussed in later sections.

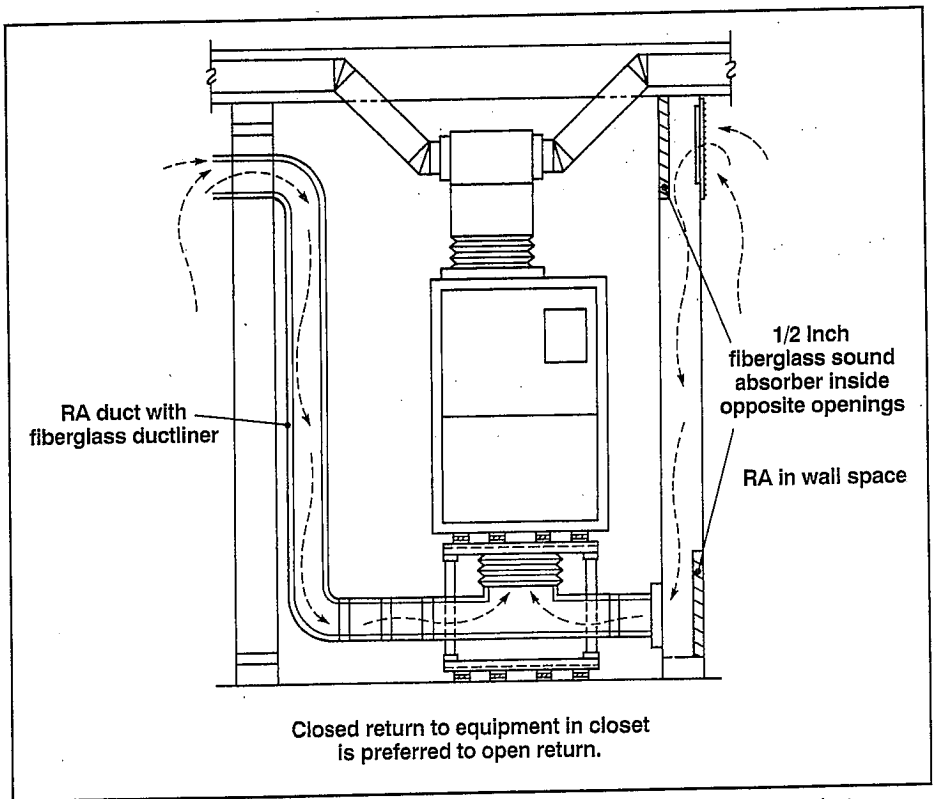


Figure 30 - Line drawing of unit isolated from ductwork, with flexible collars and closed return duct.

7. Infiltration

Air infiltration and water infiltration are most effectively addressed in different ways.

7.1. Water Infiltration

Water infiltration was thought to be the most difficult problem during the earliest design stages of the Magic-Pak. Many design solutions were tested under severe conditions to assure that rain water stayed outdoors and could cause no damage to the building.

Experience has shown that the attention given to this problem and the design solutions have been justified.

Instead of relying heavily on seals and gaskets to keep the water outside, the design contains, and channels off, the water to the outside.

The PWC model heat pump must also have the ability to channel off the defrost meltage from the outdoor coil without permitting it to refreeze in the disposal piping or form hazardous icicles. The unique and exclusive manner by which this is accomplished is discussed later.

Rain water is handled in all the Magic-Pak models in the same manner.

During periods of rain, an air conditioner must adequately channel large amounts of water through the appropriate drainage paths. The length of time and the amount of water received during that time determines whether or not the base pans will fill faster than they can drain. The amount of wind pressure will determine the amount of over-flowed water that will be pushed past the seals and imperfections in the sheet metal joints. The chassis base takes the first water entering through the condenser coil face and the upper discharge condenser air louvers, and its sides are about 1 in. high.

If the Magic-Pak unit is recessed into the wall opening, it will also likely receive the water running down the building wall above it plus the water draining out of any units in the same wall directly above. The cabinet base takes the overflow from the chassis base and can take about another 2 in. of water depth along the sides and 1 in. to the gasket joint beneath the chassis base in the return-air compartment. The design is such that all of the rain water drains to the outside by gravity. Wind pressure is generally the same over the entire outside face and should not affect the ability of the water to run out the drain holes.

If the quantity of water is excessive for a short period of time, the drain pans can be filled with water faster than it can run out the drain holes, and if a small hole or imperfection is reached by the water level, it can find its way inside the building. During high-wind conditions, the outside pressure is greater than the indoor pressure and more water can

be forced through the imperfections. Even then, the inside cabinet return-air bottom frame is designed to further retain this leakage if it should occur. However, the duct flange corners, the condensate tubing passage holes, and the four corners of the inside-cabinet return-air bottom frame must be sealed at installation to prevent any drops of water from leaving the base channels or entering the return-air duct (Fig. 31).

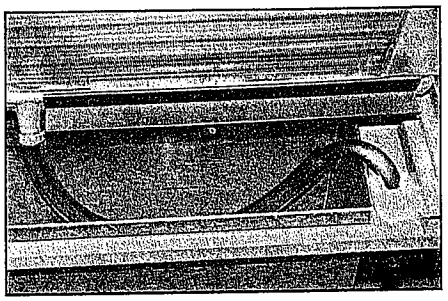


Figure 31 - Inside of unit at return-air duct flange, showing sealed corners and sealed condensate tube opening.

There have been few instances of water infiltration over the past 25 years, and the problems which have arisen have been traced to leaky flashing or sealing to the wall sleeve, or to cases where sealant was omitted or improperly installed.

7.2. Air Infiltration

The load added to the Magic-Pak units for both sensible and latent heat of the outside air entering the conditioned space must be included in the heat loss/gain calculations in accordance with standard practice.

The amount of outside air that enters the space by infiltration through the Magic-Pak unit itself, and the wall sleeve, must also be included in this calculation. A table (Fig. 32) is included to assist the designer in determining the amount of outside air to be included. The table accounts for wind velocity, and the amount of infiltration through a Magic-Pak with and without a wall sleeve. This table assumes that the unit is not additionally sealed after the Magic-Pak unit is in place. Wind velocities between 20 MPH and 72 MPH are shown.

The values for the Magic-Pak unit without a wall sleeve represent the amount of infiltration which can enter the return-air side of the circulating air blower with solid metal duct connections and flexible collars attached to the return duct opening, as well as to the supply duct opening of the unit. This does not include any leakage around the wall opening to the unit, which is assumed to be caulked air tight by the installer.

The difference between the values in the two columns represents the amount of additional CFM entering through the wall sleeve. Therefore, if the closet or enclosure around the Magic-Pak is not used as a return-air plenum and instead, a tight, ducted and insulated return-air and supply-air system is connected directly to the Magic-Pak, only the infiltration in the column for the unit alone need be used.

If the closet enclosure is on a balcony, it would not need to be sealed or gasketed around the access door as would an enclosure with an access door opening into the conditioned space.

7.3. Introduction Of Ventilation Air

Some local building codes require that a specific amount of ventilation air be brought into the conditioned space, depending upon the occupancy and use of the building. In order to comply, some builders will install a short duct with a fixed damper to the outside wall from the return duct or plenum space.

A grille is placed over the opening in the outside wall. The grille should be backed up with a piece of screening to prevent insects from entering.

This method is particularly useful in keeping the space under a slight positive pressure; however, controlling the amount of air entering the duct under high-wind conditions in high-rise buildings is very unpredictable. Therefore this practice should be limited to one, two or three-story buildings, or where adjacent walls form an air shaft offering some protection from high winds.

In any case, the amount of outside air brought directly into the inlet of the evaporator coil of the Magic-Pak unit must not exceed 25% of the total rated cooling CFM for the unit.

Controlling the infiltration during windy or variable conditions is difficult at best, as can be seen in Fig. 32. Therefore, these infiltration CFM values should not be relied upon to meet code ventilation requirements.

It is preferable to seal out any infiltration air that can enter the unit through the wall sleeve or building design and add a ventilation duct with a controlling damper to an air shaft constructed to meet local codes.

7.4. Sealing Return-Air Ducts

Whenever return ducts are connected directly to the inlet of a Magic-Pak using flexible duct collars, care should be taken to seal all cracks, holes, and joints against air leaks, if the enclosing closet can be pressurized by high wind and an unsealed wall sleeve.

If the return-air grille is high in the sidewall or access door and connected by a duct coming down to the return location in the unit, the effect of leaky return ductwork and high wind pressure during an off cycle can be reduced, but not necessarily eliminated.

7.5. Sealing Wall Sleeve

It is preferable to seal the space between the unit and the wall sleeve with expanding foam polyurethane sealant insulation or some other suitable caulking material (Figs. 33 and 15).

AIR INFILTRATION VS WIND VELOCITY

Measured Wind Velocity MPH*	Magic-Pak Without Wall Sleeve (Unit alone) Measured CFM	Magic-Pak Installed in Wall Sleeve Measured CFM
20	Too low to measure	7.1 CFM
25	Too low to measure	17.7 CFM
32	.8 CFM	30.3 CFM
45	8.8 CFM	57.1 CFM
55	21.2 CFM	77.5 CFM
65	29.6 CFM	94.7 CFM
72	37.3 CFM	110.2 CFM

*Tested in infiltration test box enclosure 11-21-89

Figure 32

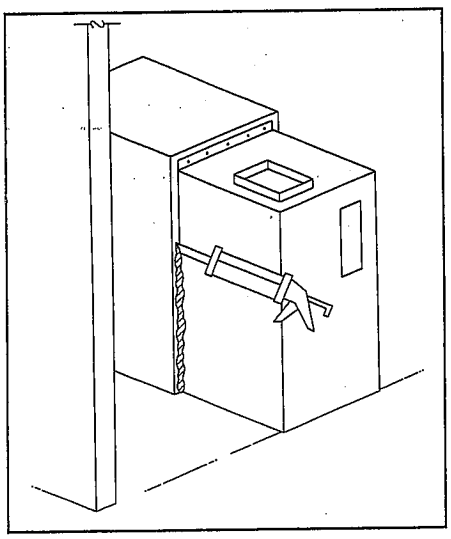


Figure 33 - For additional protection against air infiltration during periods of very high winds, fill the clearance space between unit and wall sleeve all around with polyurethane foam sealant.

8. Air Distribution

8.1. Supply Ductwork And Plenum

A supply plenum of sheet metal or 1 in. duct board should have inside dimensions of 8 in. x 16 in. for all Magic-Pak models. For sheet-steel plenums, agency approval requires a minimum of 2 in. from the top surface of the plenum to the nearest combustible material. If condensation on the plenum is likely to cause problems, it is strongly recommended that the plenum be insulated with a minimum of 1 in., 1-1/2 pound density insulation with a vapor barrier on the outside. Better still, apply the 1 in. insulation on the inside of the plenum and no vapor barrier is needed. However, a non-eroding coating or surface treatment on the side facing the air flow is still required.

The duct should also be fabricated 10 in. x 18 in. (for 1 in. insulation) on the inside to accommodate the added insulation thickness.

Sometimes the supply plenum is fabricated with a 90° turn away from the front (access door) end of the unit for a distance of 6 in. or 8 in. (depending upon the thickness of the outside wall), to allow room for "take-off" fittings on each side of the plenum. The "take-off" duct fittings are frequently rectangular to round and wrapped on the outside with 1 in. minimum insulation (with vapor barrier). If round ducts are used above a ceiling in an unconditioned space or in a service access space between the ceiling and floor above, these ducts must be insulated to prevent condensation.

Ceiling air diffusers are frequently used when ducts run between the ceiling and the floor above, or in the space created by a "drop" ceiling.

The use of duct board or molded round insulated duct for the last 6 ft. of the duct can greatly improve the quietness for any system.

8.2. Return Ductwork And Plenum

Great success has been achieved where the supply ducts are run inside and concentric to a return-air space. This is created by a boxed-in soffit below the ceiling line but inside the rooms adjacent to the Magic-Pak closet enclosure (Figs. 34, 36, and 37).

Rectangular return-air grilles are cut into the sides of the soffit; and the supply registers (matching the return grilles) are mounted on the same soffit but extended into the supply duct by a short duct.

The registers are equipped with balancing dampers for balancing the air distribution for the system.

If the room ceilings and outside wall are completed before the supply ducts and the soffits are constructed, only two sides of the soffit (return-air passage) are required; and since conditioned air (room air) is being pulled back to the unit around the supply duct, condensation does not occur even if the supply ducts are not insulated.

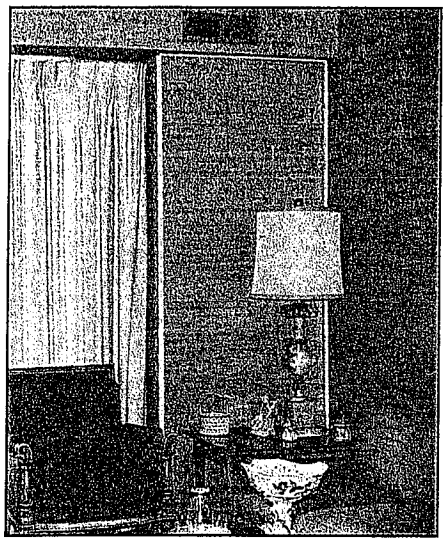


Figure 34 - Sliding panel covers equipment alcove. Return air enters alcove from end of interior wall (2 in. x 6 in. top and bottom plates with 2 in. x 4 in. staggered studs) on the right. Also, return-air space is concentric to supply duct in soffit above. This provides additional return air from rooms on the left.

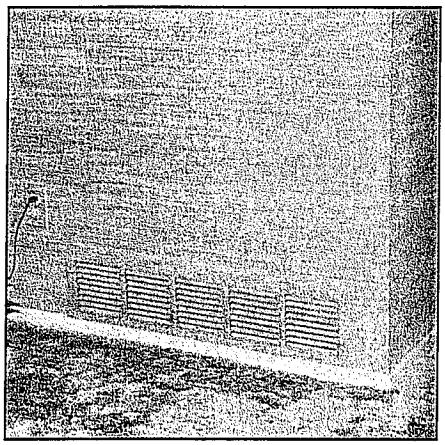


Figure 35 - Baseboard return into interior wall, with staggered 2 in. x 4 in. studs on 2 in. x 6 in. top and bottom plate. Air travels horizontally through wall space back to Magic-Pak. Another return is offset and on opposite side of wall, in bedroom.

If the supply ducts inside the soffit return space are rectangular, a layer of 1/2 in. or even 1/4 in. insulation on the inside of the ducts for 4 ft. to 6 ft. on either side of a supply register opening can reduce the level of airborne sound at that register. This arrangement also makes it easy to bring return air from a low wall or base board return grille, via the wall stud space, into the soffit enclosed space (Figs. 27, 34, 35, and 36).

If the room ceilings are not in place when the soffit is built around the supply duct, the top of the box will have to be closed to prevent drawing air from the space between the ceiling and floor above. Depending, of course, on the building construction, this space could have an excess amount of air infiltration from outdoors or from another apartment, and not be in accordance with local building codes.

If the floors are all poured or pre-cast concrete, the space below might be used for return air to the soffit with an open top if local building codes will permit.

The soffits must terminate to an opening into the closet enclosure for the Magic-Pak unit.

A duct covering the opening and sized for the airflow in that soffit should then drop down inside the closet enclosure and connect to the return opening flanges in the Magic-Pak through flexible duct connectors (Fig. 36).

If the closet enclosure is to be used as a plenum for return air, the wall sleeve must be adequately sealed, with expanding insulation or equally suitable caulk between the Magic-Pak unit and the wall sleeve, as well as between the wall sleeve and the wall opening.

The concentric soffit air space alone may not be adequate to provide the total return-air CFM requirements for the Magic-Pak unit. At least 300 sq. in. of free area is needed to keep 1,000 CFM of return air below a velocity of 500 ft. per minute. If all of the soffit openings into a closet enclosure do not total 300 sq. in., additional return-air openings into the closet space (or into the return-air duct connected to the unit) must be provided.

If the closet enclosure extends into the living space, the side-wall construction using 6 in. top and bottom plates but 2 in. x 4 in. studding staggered on 16 in. centers, as described earlier (Fig. 27), provides an effective way of allowing return air to travel both horizontally or vertically within the wall.

A grille in the room-side of such a wall can be offset from the opening into the closet, (or closed return duct to the unit) either horizontally or vertically (as for a high side-wall return grille).

The soffit-end openings can discharge into this side-wall air space at the living-space side of the wall, near the top, and an insulated, tightly sealed metal return duct to the inlet of the Magic-Pak can be connected to the unit side of the wall almost at any convenient place.

The soffit bridging should be 1 in. x 3 in. lumber or furring strips applied with the wide dimension running parallel to the duct to maximize the free area for air flow around the supply duct (Fig. 37).

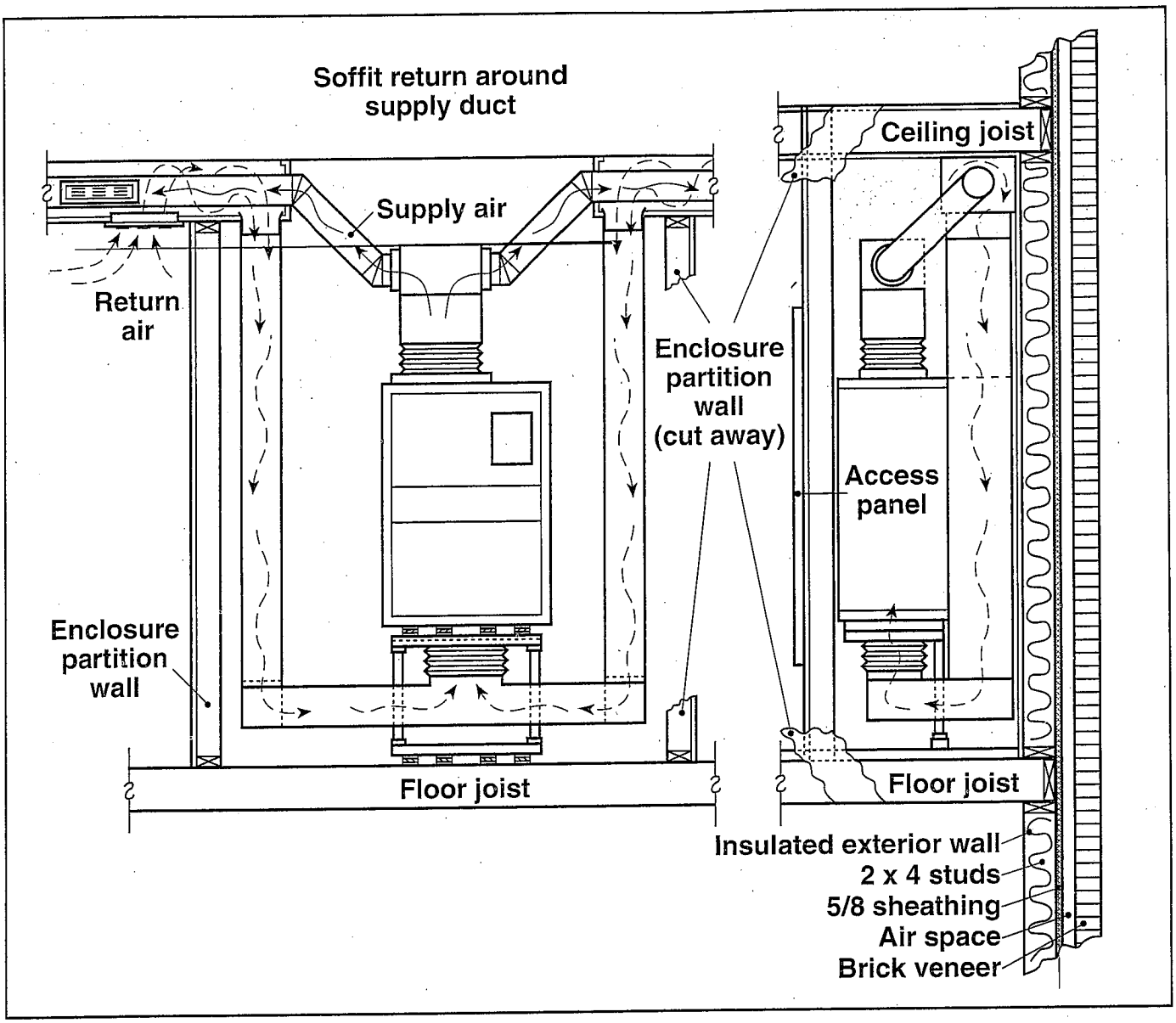


Figure 36

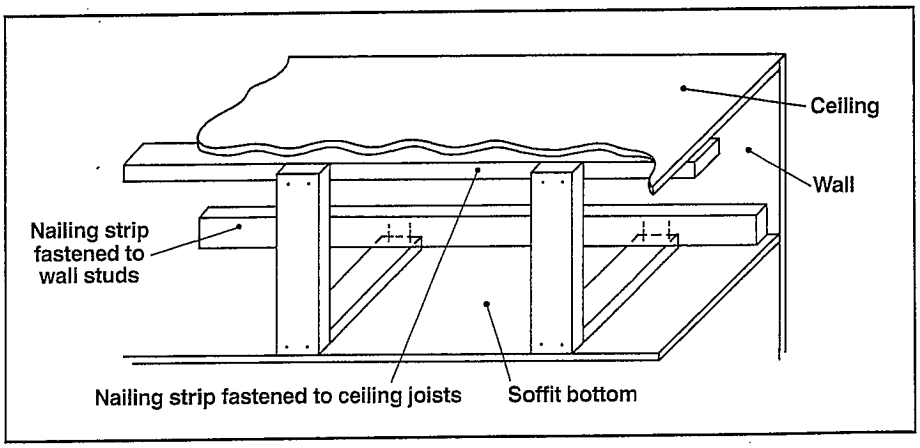


Figure 37

9. Outside Decorative Facades, Grilles Or Louvers

9.1. Grille And Louver Furnished On Magic-Pak

The appearance from outside is the same for all Magic-Pak models of any heating or cooling capacity. The upper louvered grille is the same for all models.

The louvers in this upper grille are turned slightly upward to direct discharge air away from the intake of the condenser coil below it, to minimize recirculation of air, and to present a better appearance by avoiding line-of-sight observation of the space and action taking place behind the louvered grille.

The lower grille covering the condenser coil is on the intake side of the condenser coil, which can be more easily cleaned from the outside where dirt, leaves and other airborne debris can collect, as opposed to a "blow through" design which deposits this debris on the inaccessible side of the coil. In buildings over three stories, the likelihood of collecting such debris on the outside is very much reduced, and the action of rain and other elements ordinarily will clean away any accumulation.

*(**Note:** The following procedure does not apply to PWC units. These grilles cannot be removed from the inside.)*

If it becomes necessary to remove the upper and lower grilles for painting, cleaning or repair, they can be removed from inside the building. To remove the grilles, first remove the slide-out chassis, and reaching in, hold onto the bottom edge of the lower grille and pull it toward you to completely remove it. Since the lower grille holds the upper louver in place, the upper louver can now be pulled straight down (like closing a window) into the space formerly occupied by the lower grille and likewise be removed.

Simply reverse the procedure to replace these parts and the chassis.

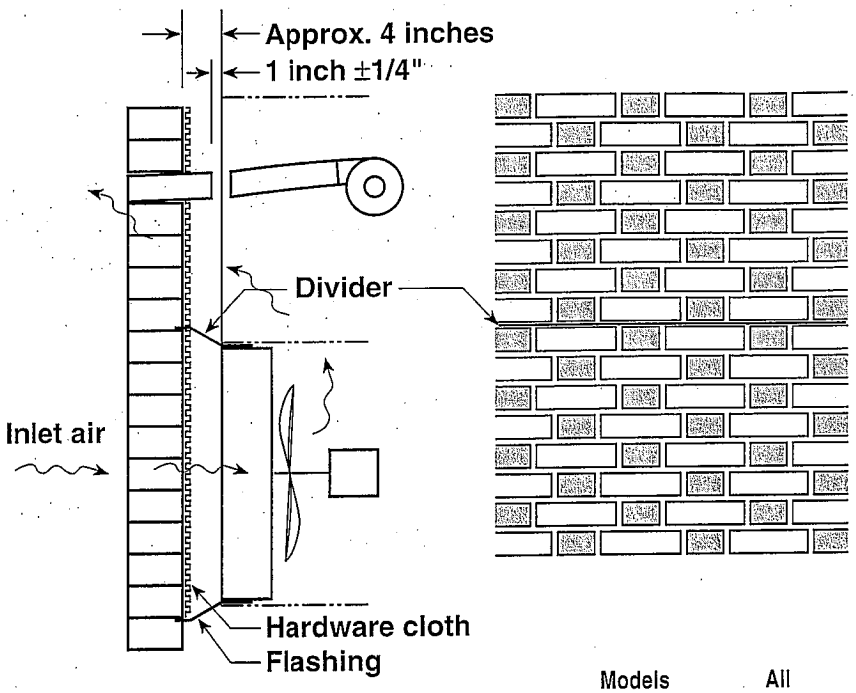
The upper louver is held in place by the lower grille and, as a safety feature, neither can fall outward without considerable maneuvering effort.

Also, the lower grille is held in place by the inserted chassis. Even with the chassis removed, the lower grille should stay in place to keep the opening covered until it is purposely removed.

9.2. Outside Appearance Variations

Magic-Pak units eliminate the unsightly appearance of external condensers and cooling towers, and integrate unobtrusively into the building design. The neutral-toned, powder paint grille finish complements any exterior wall. In addition, decorative facades or grilles can sometimes be placed over the outside of the Magic-Pak units, but not all designs are suitable.

Tests have been run in the laboratory to find out what effect several different designs have on the performance and longevity of the Magic-Pak units. Almost every obstacle to air flow placed near the outside grilles showed some deterioration of performance.



INDICATES OPENING ON WALL

MINIMUM FREE AREA:	Models HWC/EWC 18, 24, 30	All Other Models
INLET =	260	300
DISCHARGE =	340	380

- DIVIDER MUST BE ADDED BETWEEN INLET AND DISCHARGE AS SHOWN.
- 1/2" HARDWARE CLOTH MUST BE ADDED TO INSIDE SURFACE OF WALL AS SHOWN.

Figure 38 - Brick-pattern facade with free area table and flashing, plus divider baffle and flue-tube extension.

In the least successful designs, problems resulted from recirculation of air between the upper condenser air discharge and the lower condenser air intake.

Elimination of a recirculation path by the use of a tight fitting close-out baffle installed horizontally between the grille or facade and the unit at the top edge of the condenser coil is vital to prevention of recirculation.

Beyond that, providing sufficient free area for intake and discharge condenser air, as specified in Fig. 38, has usually resulted in satisfactory performance.

It is still not considered good practice to use a louvered grille which has all of the louvers pointing downward.

A grille which has the upper section of louvers pointing upward and the lower louvers pointing downward, and are at no more than a 45° angle from horizontal, can work satisfactorily against the outside of the unit, if the louvers are flat and thin (1/8 in. maximum) and have vertical mullions to prevent vibration and noise. The grille must have a free air face dimension (inside its frame) at least as large as the unit, and preferably 2 in. to 4 in. higher at the top, for less impingement of condenser discharge air, and 2 in. to 4 in. lower at the bottom to permit water drain-age out through the louvers (Fig. 39).

If the Magic-Pak unit and such a grille are to be separated by more than 1 in., a horizontal baffle must be used to prevent recirculation of condenser air behind the grille. Also, flashing must be installed between the bottom of the wall sleeve (or unit) and the grille frame if the space is a result of recessing the unit.

If such a grille is held away from the building and the Magic-Pak such that the bottom of the grille is open, flashing would not be required (Figs. 40 and 41).

Blowing rain or snow must drain freely from the unit. At the same time it must not be permitted to drain behind a facade or added grille causing water damage to the building or floors below.

See the table, Fig. 38, for the free area requirements for facades of masonry or wood louver construction.

Illustrations of louvered grille designs with all of the louvers pointing down are shown in Figs. 42 and 43.

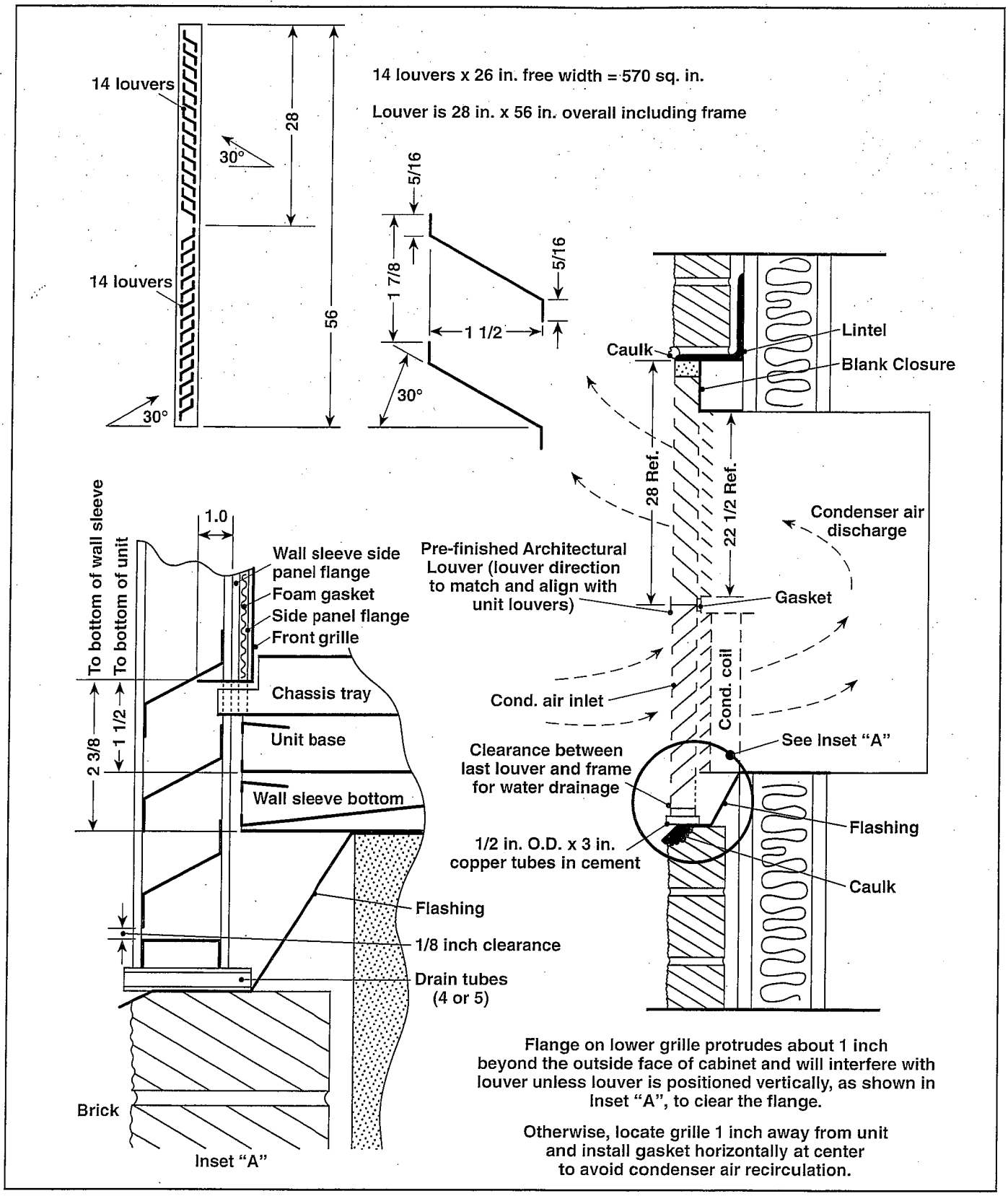


Figure 39 - Louvered facade shown in cross section and enlarged section with dimensions.

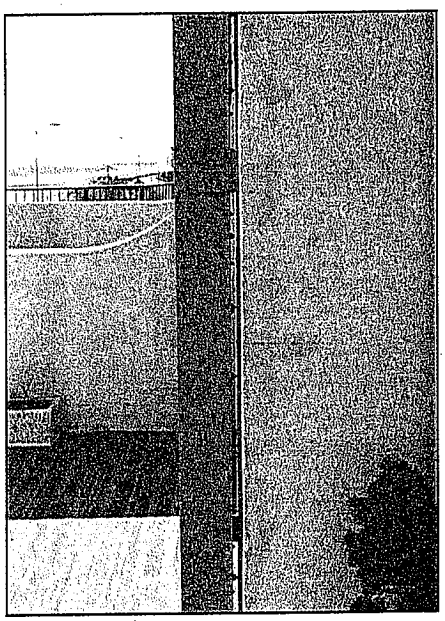


Figure 40

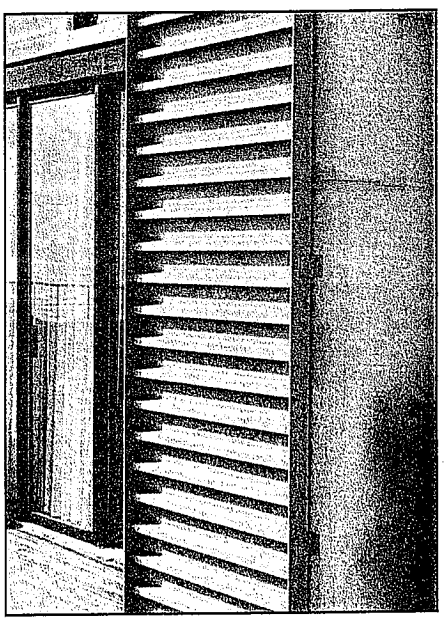


Figure 41- Grille stand-off and open bottom allow drainage. A divider to prevent recirculation is still needed.

In all of these, the louvers are separated from the face of the Magic-Pak unit by a distance of 4 in. to 6 in., with the recirculation barrier baffle at the top edge of the condenser coil closing off the space. Also, the free area of the louvers is more than double the normal requirements so that the air velocity through the upper louvers is very low and the resistance to be overcome by the condenser fan is held to a minimum.

Where the same louvers run all the way up the building in front of many stories of Magic-Pak units directly above each other, a second barrier baffle is located at each floor line to prevent interaction between units (Fig. 44).

9.3. Discharging Flue Gas Products From Gas-Fired Models

The combustion products must be allowed to discharge freely and at sufficient velocity to project away from the outside surface minimizing condensation and corrosion. Inhibiting the free discharge of the combustion flue gases creates an undesirable back pressure within the heat exchanger. This can contribute to poor combustion and a dirty flame. Also, the combustion products must not be allowed to recirculate back into the fresh air intake for the unit combustion air.

If it is necessary to locate an HWC (gas-fired) model in an inside corner of a wall, where the adjacent wall is at a right angle and is on the same side as the flue gas discharge tube, the adjacent wall must not have any obstruction or protrusion extending away from it that would interfere with the free discharge of the flue gases or would contribute toward recirculation of the flue gases.

Any protrusion on an adjacent wall must not extend into the path of the flue gases by an amount in excess of 1/2 the distance from the louvered grille to the protrusion.

Condensation of flue products, which emanate from the combustion blower discharge tube of HWC models, represent a possible cause of corrosion and ice build-up. However, in cases where a grille with louvers pointing upward has been placed close to the unit (1 in. or less), this has not been a problem. If a grille stand-off is more than 1 in., the grille material should be protected from corrosion by the flue products of combustion. One should specify a suitable paint for aluminum or steel, or select some other acid-resistant material.

9.4. Masonry Pattern Facades

We have found that these concerns for unit performance and satisfaction can be met by the use of certain masonry facade decorative patterns and louver designs.

The masonry patterns must meet the following criteria:

1. *They must have a minimum free area as follows —*

Min. Sq. In. Free Area		
	Models HWC/EWC 12, 18, 24, 30	All Other Models
Inlet	260	300
Discharge	340	380

(Figs. 38, 45 and 46)

2. *They must be at least as wide as the unit and extend both above and below the unit height in order to gain sufficient free opening area and to facilitate drainage.*

3. *A minimum space of 4 in. must be maintained between the unit and the inside of the masonry to permit air to be*

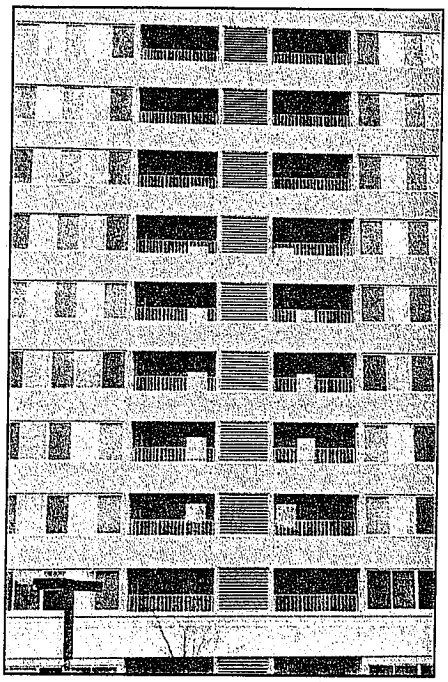


Figure 42

Figure 43 - PWC heat pumps behind louvered facade near Washington, D.C. Generous free area and recirculation-prevention baffles contribute to success.

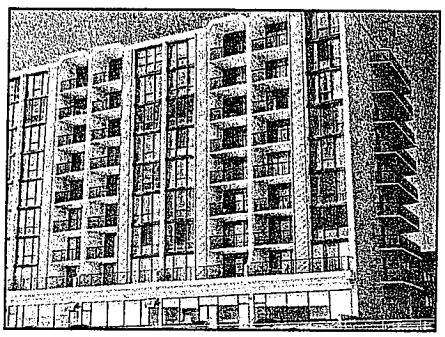


Figure 44 - Ocean-front condominium with continuous stand-off louvers extending full height of building. To prevent recirculation, dividers separate each floor level, and are also placed at each unit, near the upper edge of the condenser coil.

distributed over all of the available free area with minimum resistance.

4. A divider of galvanized or aluminum sheet metal must be provided between the top edge of the condenser coil and the masonry to prevent recirculation of discharge air back into the condenser coil intake. This baffle must be full width and fit tightly both to masonry and to the unit and not be dislodged. Armstrong suggests that it be flashed into a mortar joint if one is conveniently in line with the top edge of the condenser coil.

5. A bird screen of 1/2 in. x 1/2 in. mesh galvanized hardware cloth should be placed over the inside of the facade openings.

6. Refer to Fig. 38. An extension tube to direct flue gases to the outside of a masonry facade must be provided. If the flue gases are allowed to impinge on the inside surface, condensation of the acidic gases is likely to occur with deteriorating effects to the mortar.

   Extending the tube all the way through the openings will allow the flue gases to be projected away from the facade.

   Five louvers in the Magic-Pak grille directly in front of the flue tube should be straightened to a horizontal position with needle-nose pliers or wide-jaw, blade- type "vise-grip" pliers.

   Cutting away the five louvers with tin snips is not advisable, since the exposed metal cut edges will rust.

7. The bottom of the unit must be flashed to the facade if multistory installation behind a facade could allow a unit on a lower floor to discharge heated condenser air into the intake of a unit on the floor above (Figs. 38, 45 and 46).

9.5. Louvered Grilles

The provisions above also apply to louvered grilles. In addition, louvered grilles must meet the criteria listed below:

1. Do not use a grille with louvers that direct the discharge air at an angle downward. The angle should discharge upward.

2. The free area must be about 300 sq. in. minimum for the discharge air and 300 sq. in. minimum for the intake air.

3. The louver angle must not exceed 45° with horizontal.

See Fig. 39 for an example of a louver which has been tested and found to work without performance deterioration of the Magic-Pak unit.

Stand-off bracket material, and even bolts and screws, should be considered for corrosion protection.

Some contractors have used a flue tube extension tube between the unit louver grille and the decorative louver spaced several inches away.

A 3 in. or 4 in. diameter duct/tube fastened to the decorative grille, concentric with the flue tube and pitched slightly downward (away from the unit) may last if made of aluminum or galvanized steel; but a better material choice would be a non-metallic, high-temperature flue-pipe material in 3 in. or 4 in. diameter.

Caution:
After leaving the factory, the HWC unit venting system must not be altered in any way. Agency Approvals can become void if any modifications to the HWC unit are attempted.

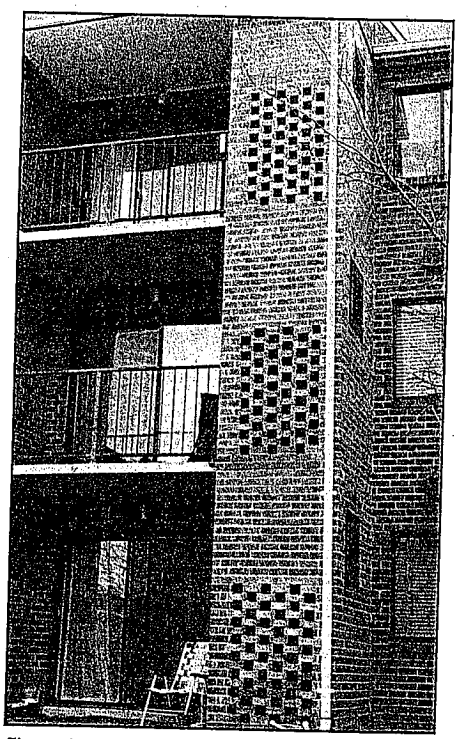


Figure 45

Therefore, any references here to the flue-tube extensions or baffles should be interpreted as being fastened to or held in place by the decorative facade or louver itself or by some means other than attached to or touching the upper grille of the HWC unit. Any extension flue tube must not approach the upper grille of the HWC unit any closer than one inch.

Another type of decorative facade that has been in use with PWC heat pumps is shown in Figs. 42 and 43. Note that the air passages are large, permitting lower air velocity and consequently less air resistance for the condenser fan. Although not within view in the photographs, there are air divider baffles installed to reduce recirculation behind the louvers.

The units are set between 10 in. and 12 in. back from the louvers; but because they are heat pumps, no flue-gas condensation problems will ever be encountered.

These ocean-front condominium units with louvered facades (Figs. 40, 41 and 44) have a very good service record.

The louvers appear to be relatively "tight" for condenser air flow. However, the louvers run continuously up the face of the building and the space is utilized between floors for air passage, while recirculation in prevented by air-stop baffles at each floor and at the top edge of the condenser coil of each Magic-Pak unit.

It should be noted, however, that these Magic-Pak units are all-electric EWC models, and flue gas condensation was not a consideration.

This type of continuous louver protects against water infiltration during storms and hurricanes for these Atlantic beach-front properties.

The Magic-Pak may be located right up to a grille, provided the height of the grille is more than the height of the unit and the center portion of the grille (where the louver direction reverses from up to down) is in line with a 2 in. wide space just above the top edge of the condenser coil.

The bottom of the unit must still be flashed to the bottom edge of the louver, unless other provisions are made to prevent water from entering the building (Fig. 39).

Do not attach anything to the slide-out chassis edge (where it protrudes from the unit cabinet) which might inhibit removal of the chassis or cause a seal to be broken in removal of the chassis.

Fig. 39 provides a sketch of a suitable louver. With this particular louver design, there is no need to remove the grilles from the unit or to add a bird screen to the louver. This louver extends above and below the unit to provide better airflow and water drainage.

These are examples of a few of the grilles and facades in use throughout the country.

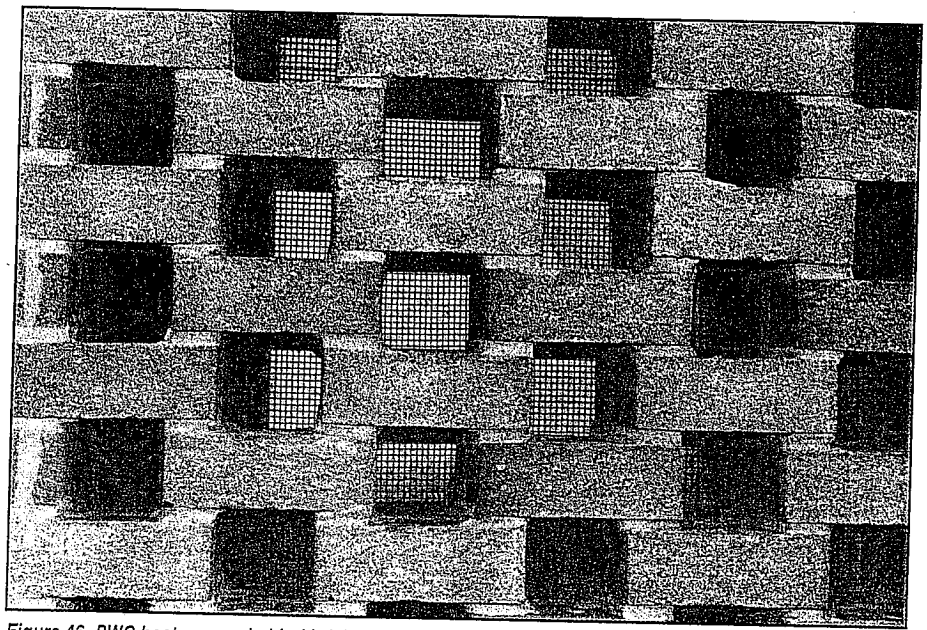


Figure 46 -PWC heat pumps behind brick facade of Fig. 38.

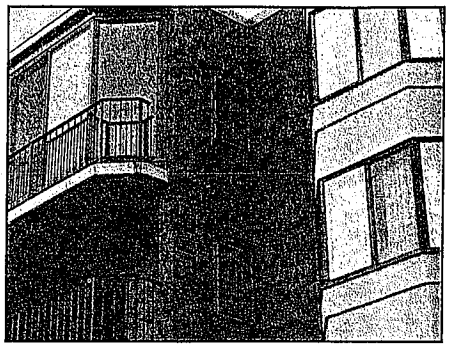


Figure 47 - Sound-deflector facade grille to deflect sound away from protruding bay window in close proximity to Magic-Pak outdoor side.

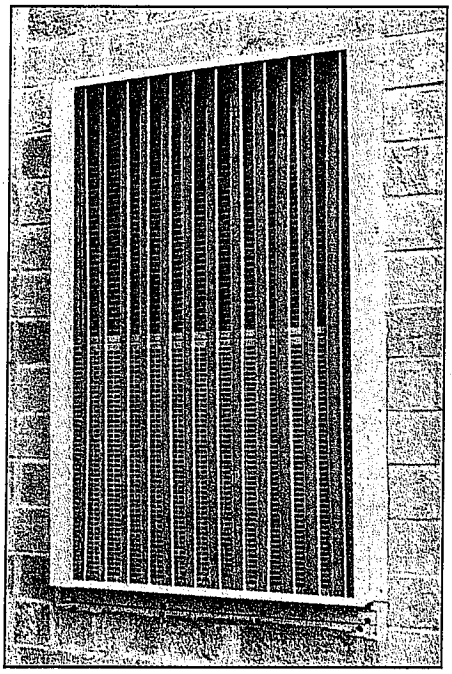


Figure 48 - Sound-deflector facade. Note—Drain holes are not obstructed.

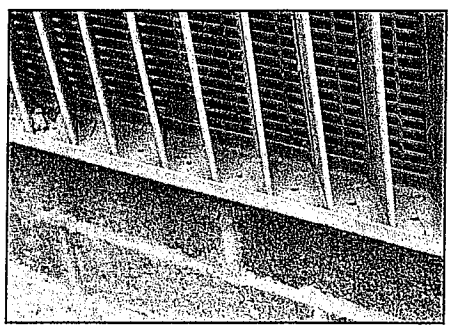


Figure 49 - Sound-deflector features painted-aluminum construction.

Not all have been documented for performance deterioration, but if the designer stays within the guidelines of the recommendations stated here, satisfactory performance and service life will result.

Since higher operating costs represent the most prominent result of any facade placed in front of a Magic-Pak, the designer may choose to make "trade-offs" for the sake of appearance and cost concerns.

In order to keep operating costs to a minimum, the restriction of condenser air flow must be minimized and the recirculation of condenser air at the outdoor face of the Magic-Pak must be prevented. These are prime considerations over which the building designer has control.

9.6. Control Of Sound With Louvered Grilles

Another type of decorative grille has been used to control sound. This grille utilizes large louvers placed vertically and mounted at an angle to deflect sound away from glass areas which are in an adjacent wall (Figs. 47, 48 and 49). The grille is often painted to match the building and does not detract from the building's appearance. The large air passages and vertical assembly do not contribute to performance deterioration by reason of recirculation or restriction of condenser air.

10. Condensate Drain

The Magic-Pak concept provides for the disposal of condensate water to a drain or waste-water line inside the building.

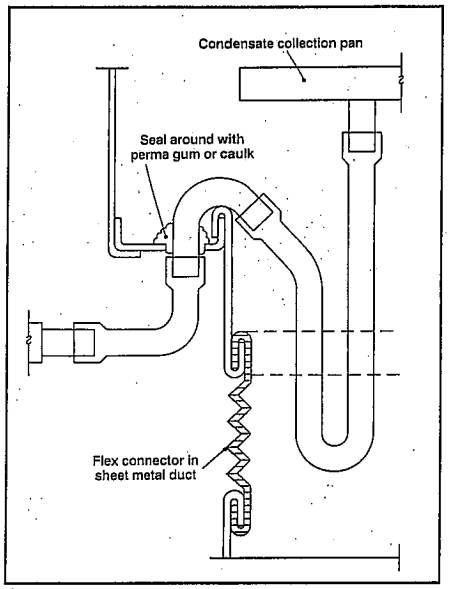


Figure 50 - Enlarged section of base with condensate-tube exit of unit for closed-duct return systems.

Although some installers simply run a pipe to the outside through the wall in which a unit is mounted, this practice is not recommended because of the likelihood of staining the outside of the building. Some building codes prohibit this practice, because window air conditioners installed in such a fashion drip condensate on passersby below.

So far, attempts to evaporate condensate on the condenser coil surfaces as a means of condensate disposal have not proven to be consistent and reliable. This is especially true in coastal areas where salt air contributes to the accelerated deterioration of the coil.

Piping the condensate to an inside drain is consistent and reliable and should provide many years of trouble free service.

The connection to the condensate collection pan is located in the center of the pan directly below the air filter.

A length of clear plastic tubing with a heavy wall thickness (to prevent kinking) is provided. One end slips tightly over the stub-tube connection on the pan. The clear tubing is looped to form a trap, then slipped over a piece of 5/8 in. O.D. copper tubing (or PVC tubing) and connected to a drain according to local codes.

Although the looped plastic tube forms a trap when filled with condensate water during cooling operation, it is likely to be dry during prolonged periods of heating operation. The pan is always under negative air pressure when the circulating blower is in operation.

The building drain or waste line should be connected as local codes may prescribe for any other kind of air conditioning system, be it residential or commercial. This usually means to an open drain trap (Fig. 51).

There are many ways to do this according to good plumbing practice and local codes, but in no case should the condensate tubing be connected directly to a sanitary sewer or vent line.

When ductwork is connected to the return-air opening of the Magic-Pak unit, the round holes provided in the base (Fig. 31) should be used to exit the tubing by the addition of a piece of 5/8 in. O.D. copper tubing. This should be formed beyond 90° (to about 110°) and hooked through the hole. A short (3 in.) length of clear plastic tubing cut from the length of tubing furnished may be used as a coupling to connect to additional 5/8 in. copper tubing or to PVC pipe, leading to the open trap drain (Fig. 50).

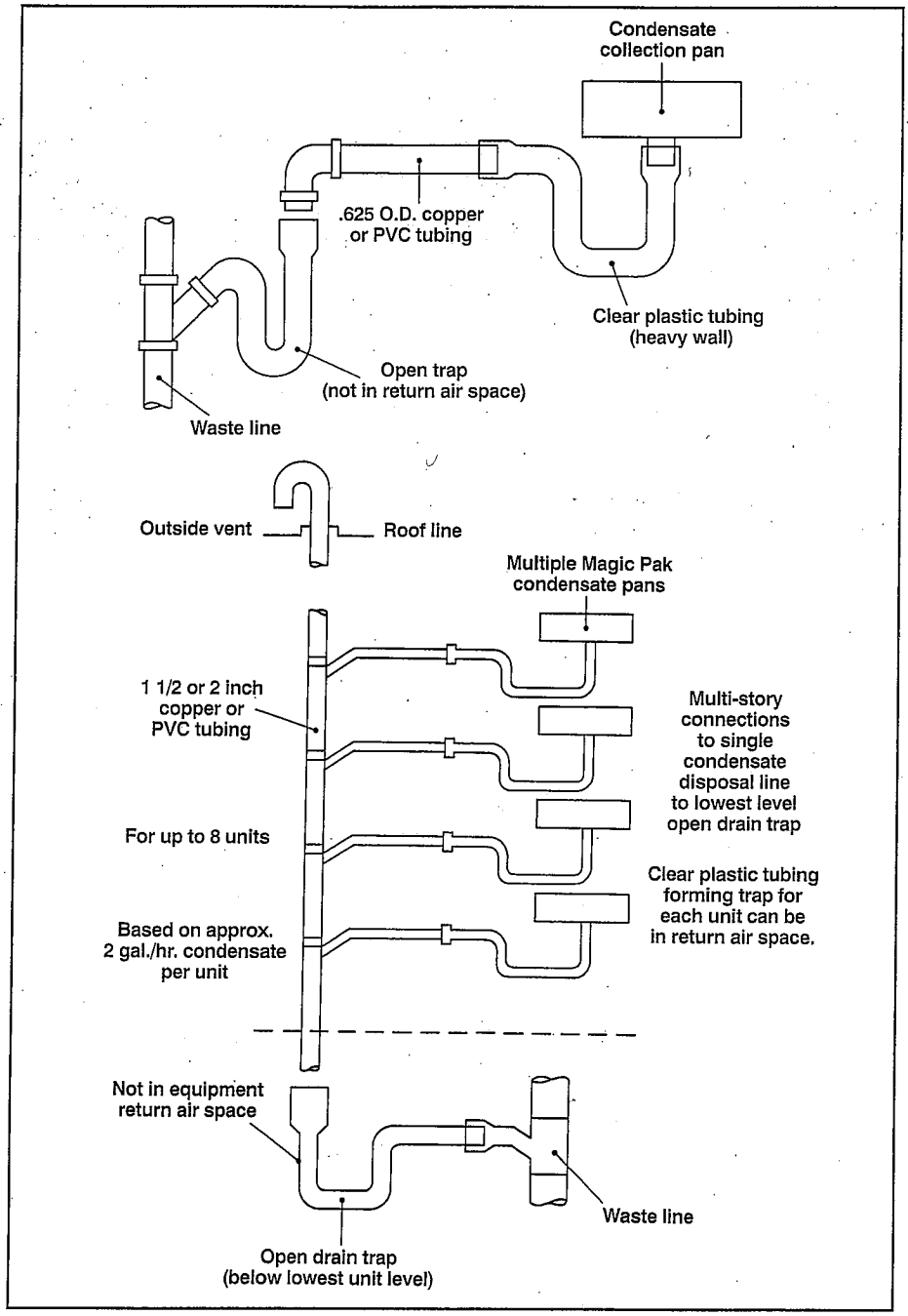


Figure 51 - Line-drawing schematic of multistory condensate-removal system with trap at bottom floor of system (open trap), but closed in each floor enclosure used as return plenum. Also note — Individual open-trapped condensate lines for closed-ducted returns.

The clearance space around the tube in the hole should be sealed with Permagum or suitable caulking material as indicated in Fig. 31.

If the wall sleeve and closet are both sealed against infiltration and an open return is used, the trap-looped tubing can connect directly to the external pipe to the drain line without passing through the holes in the unit base frame (Fig. 51).

11. Electrical-Service Wiring

Each Magic-Pak model is shipped with installation instructions which describe the options for electrical-supply wiring connections to the specific unit model. All instructions defer to the code requirements of the agencies of local jurisdiction.

In most cases, the HWC gas-fired Magic-Pak units will be connected to nominal 230 volt, 60 Hz, single-phase power. The same units can be connected to 208 volt power if assurances can be given by the power supplier that a minimum of 197 volts will always be available. Cooling capacities will be reduced by about 1% for 208 volt operation. Gas heating ratings are not affected. The EWC electric units and the PWC heat pump units are affected on the cooling cycle in a manner similar to the HWC models, as described above. However, since the EWC and the PWC heat pump models both contain electric resistance strip heaters in the heating cycle, the supply line voltage has a bearing on the heating output of the strip heaters.

The "rated" voltage of the heaters is 240 volts. The nominal KW is for a 240-volt rating.

The remainder of the Magic-Pak unit is "rated" at 230 volts, but has an operating voltage range from 253 to 197 volts, in accordance with the A.R.I. Standard 210/240.

The actual BTUH output of the electric strip heaters varies with the square of the voltage ratio; so if the expected operating voltage at a job location is known or can be determined, the actual heater output can be determined, or a heater optional size can be selected to meet a heating requirement at any chosen voltage.

Example:

- *At 240 volts, 9.2 KW delivers 31,400 BTUH*
- *At 208 volts, the same heater delivers*

$$\left(\frac{208}{240}\right)^2 \times 9.2 = 6.9 \text{ KW or } 23{,}550 \text{ BTUH}$$

The heat output for any other application voltage may be determined in the same way.

The specification sheets for each model also include the ampacity values required to determine wire sizes, in addition to the minimum fuse size requirements for both single-entry and multiple-entry connections to the units.

12. Air Filter

All Magic-Pak units are equipped with an air filter covering the entering face of the indoor coil in the slide-out chassis. This air filter is accessible for replacement or cleaning by removal of the lower front compartment cover (see front of specification sheet).

In the event that a wall or ceiling register containing an air filter is selected for use in the return system, the filter in the chassis should be removed. The return-air duct system should be tight from the filter to the coil in the chassis, and a closed duct-return connection to the unit must be used.

Access for removal of the cooling chassis must not be compromised; however, all of the air entering the cooling coil must be filtered.

The external filter grille (or grilles, if more than one is to be used) should be selected for a face velocity not to exceed 300 ft. per minute, or an air friction not in excess of 0.12 in. W.G.

13. Special Considerations For PWC Heat Pumps

The same Magic-Pak concept is maintained, and after decades this combination of features is still unique in the industry:

1. Single package.
2. Individual temperature control.
3. Individual power metering if desired.
4. Ducted circulating air.
5. Slide-out chassis for quick non-technical service, if required.
6. Replacement-chassis interchangeability with older models.

13.1. Heated Meltage Path

In addition to the traditional method of collecting and draining away the condensate accumulated during ordinary cooling season operation, the PWC heat pump models incorporate a unique and exclusive method of disposing of the meltage which occurs during the defrost cycle in the heating mode in normal operation. The purpose is to prevent such meltage from running down the face of the building to re-freeze or to form icicles.

A drain pan is used to support the bottom of the outdoor finned coil. The end of the pan extends to the indoor end of the slide-out chassis and terminates in the indoor return-air chamber with another 5/8 in. O.D. stub-tube fitting. This stub-tube fitting and the regular cooling condensate pan stub-tube fitting are connected by means of short pieces of clear plastic tubing. Connect to an inside waste drain line in the same manner as described in Chapter 10, for a cooling only air conditioner.

The unique feature of this trap design is that it always has a water seal, whether in cooling or heating mode.

As the defrost meltage drains off the outdoor coil during the heating-mode defrost cycle, it is collected in the pan beneath the coil and channeled into the trap in the return-air environment of the building. The meltage is kept from re-freezing in the pan before it gets to the inside by the warm refrigerant liquid circulated through copper tubing inside the bottom of the pan.

The additional sub-cooling of the liquid refrigerant also contributes slightly to an improved C.O.P. in the heating mode. However, the main function is to permit drainage without using any additional electrical energy (such as electric-heater elements) and to eliminate the possibility of drain-pan freeze up blockage and subsequent overflow down the face of the building.

This system has demonstrated superior performance and reliability in all kinds of climates in the U.S. and Canada.

13.2. Defrost Control

Current PWC models incorporate an electronic defrost control "time initiated and temperature terminated." The timing is adjusted at installation.

13.3. Thermostat

The standard thermostat used with all PWC Magic-Pak heat pumps is a single-stage cooling and two-stage heating with manual change-over from cooling to heating. The first stage of heating controls the operation of the compressor, while the second stage brings in the auxiliary strip heaters if the room temperature cannot be held to the thermostat temperature setting by the operation of the compressor alone.

There is no low-temperature lockout of the compressor, since field experience has shown that it is better for the compressor to run during periods of low outdoor temperature, even though the C.O.P. may be close to 1.00 and most of the heat is being furnished by auxiliary strip heaters.

If high compressor discharge temperatures should occur, the compressor is protected by a discharge line thermostat.

However, some contractors want a thermostat on the wall that displays an "emergency heat" switch and a light to indicate when it is in the "emergency heat" position. When placed in "emergency heat" position, as indicated by lights on this thermostat, the compressor operation will be locked out and the auxiliary heat relays will yield to control of the first stage of the thermostat.

Also, if this type of thermostat is used, and if the emergency heat switch is in the "normal" position, no lights will come on until the second stage of heat is called for by the thermostat. At this time, only the blue light will come on to indicate the operation of the auxiliary heaters.

14. Special Considerations for Gas Units

One of the advantages of Magic-Pak units is that combustion air is not taken from the occupied space.

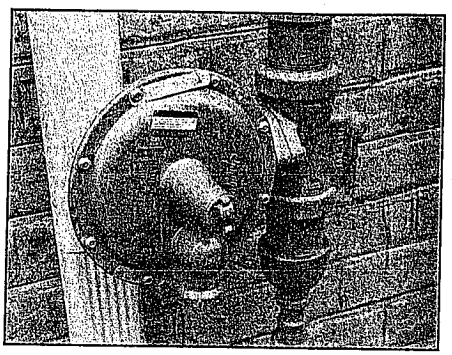


Figure 52 - Gas-main supply line is reduced to 2 psi as it enters the building.

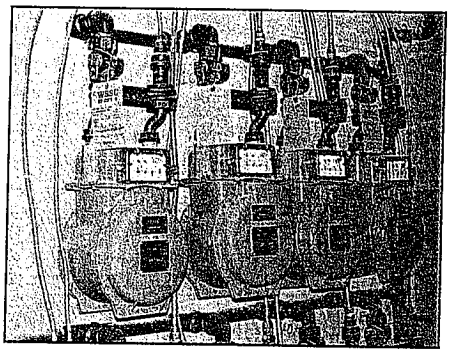


Figure 53 - Meter bank for 2 psi distribution.

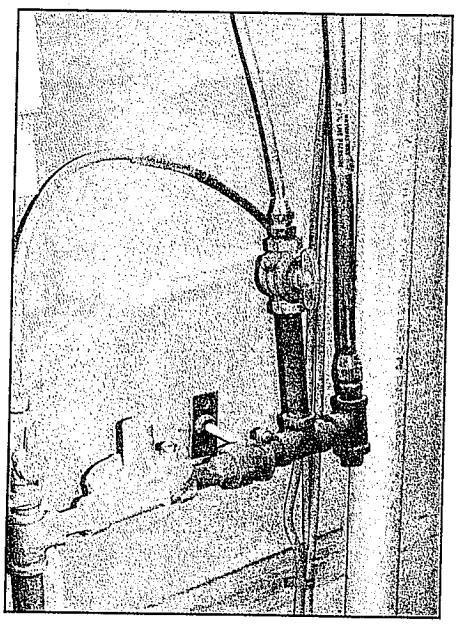


Figure 54 - Regulator reduces 2 psi gas to 7 in. W.C. for furnace and water heater, while 2 psi line extends to cooking range and its own regulator some distance away.

Gas-fired Magic-Paks take combustion air directly from the outside in close proximity to the flue-gas discharge tube. Since the two openings are close enough physically to be nearly at the same pressure under various wind conditions, combustion is affected very little by high wind pressure.

A centrifugal combustion-air blower provides the displacement and pressure required to overcome the internal resistance of the heat-exchanger passages, while drawing in the correct amount of air for efficient combustion.

The materials used in the construction of the heat exchanger, combustion blower, flue gas discharge tube and outside louver grille are consistent with the requirements for corrosion resistance for the application, and consider the presence of moisture and the formation of acids through condensation internally and externally on the louvered grille.

The flue-gas velocity and temperature are usually high enough to project the gases beyond the louvered grille before they condense, but in the event that erratic wind conditions could blow them back, the corrosion protection is provided.

If a decorative grille or facade is contemplated, refer again to paragraph 9.3.

14.1. Gas Distribution In Multi-Family Buildings

In some areas the trend has been toward the use of "2 psi" gas distribution systems. This permits the use of smaller, easier-to-install tubing throughout the building, instead of much larger iron pipe supply lines.

Individual metering of gas usage for each apartment unit is an attractive option to building owners in areas where gas is

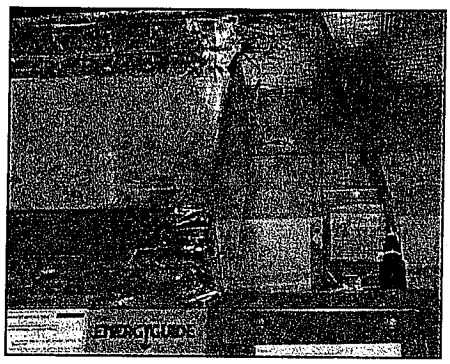


Figure 55 - 2 psi gas from regulator (Fig. 54) is reduced to 7 in. W.C. for short run to furnace nearby.

preferred over electricity as a heating fuel. Gas from the supply mains is reduced to 2 psi for the individual meters located in a central meter room (Figs. 52 and 53). It is then directed to each individual apartment through small, relatively flexible tubing at 2 psi pressure. This 2 psi gas pressure is then reduced to nominal 7 in. water column (or whatever pressure the appliances require) by another regulator in the apartment.

The additional regulator is sized for the total BTUH load of only the appliances served in the apartment, such as a gas range, gas clothes dryer, gas water heater, etc., as well as the Magic-Pak gas unit.

If one of the appliances is located too far away from the others to permit use of small-diameter tubing, it may be necessary to install a tee ahead of the regulator and run the 2 psi gas to it, locating a second pressure regulator at the distant appliance (Figs. 54 and 55).

This is only an attempt to explain the concept for this type of gas distribution system. If the building designer wishes to further explore the selection, design and cost details, the gas utility company serving the area of the building location must be consulted for additional information and local code requirements.

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