Sound Control Manual − Sound Construction
Details, Specifications, and Construction

Second in importance only to selecting the right system, are measures to ensure that the installation is performed in such a way that the rated performance is actually obtained. This involves preparing the proper details, including the necessary provisions in the specifications, and instructing the workmen of all related trades of the importance of special procedures. It is impossible to forsee all of the conditions that will occur in different building designs, but an understanding of the factors and principles outlined here can easily e applied to other comparable situations.

In preparing the detail drawings and specifications, it is important to remember that the contractor cannot be expected to perform any sound−control work that is not included in the documents. It is the responsiblilty of the architect to cover all details. However, the contractor and his agents have an obligation to notify the architect of any omissions that come to their attention.

One of the most important factors in sound control construction is the integrity of the systems. Changes in the design, material substitutions, and deviations from the details and specifications will jeopardize the sound attenuation performance of the construction. To safeguard the sound attenuation qualities expected, it is essential to specify the exact materials used in the sound tests. Other materials, even thos that seem to be identical products by other manufacturers, may destroy the acoustical balance of the system. Cost−cutting and expediency have no place in the construction of sound−conditioned environments.

Equipment

An important inclusion in specifications is the quietest equipment available. Even in comparable mechanical equipment of similar capacities, there are differences in noise level. Investigation will determine which manufacturer's equipment is consistently quieter. If the cost is a little higher, it can be justified. Also certain designs in equipment tend to operate with less noise; for example, squirrel−cage blowers on furnaces, air conditioners and exhaust fans tend to be quieter than blade type fans.

Leaks and Flanking Paths

The performance of sound attenuation systems is no better than the performance around and through them. Leaks and flanking paths must not be presentto allow sound to bypass the sound control system. Probable paths are over or under a partition, around the edges of a floor−ceiling system, along a continuous wall past several partitions, and through doors, windows, electrical outlets, built in cabinets and other partition penetrations

Flanking over a partition is very common, especially through the joist space above the ceiling. The sound travels up through the ceiling into the plenum and down through the ciling on the other side of the partition. The sound attenuation between the rooms will be only as good as the performance of the ceiling diaphragms. It will be even poorer if the ceiling diaphragm is continuous, creating a direct transmission path over the partition. (See Figure 78)

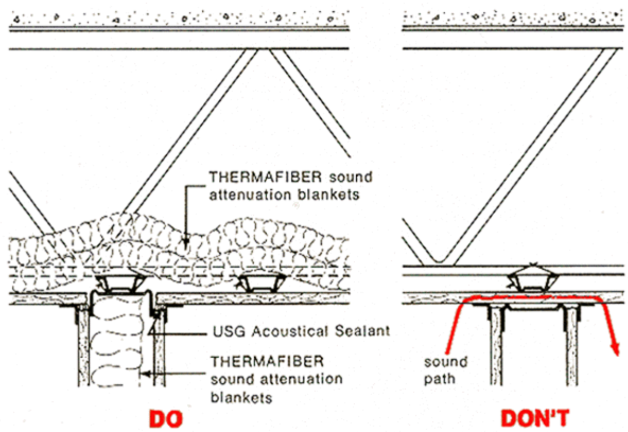
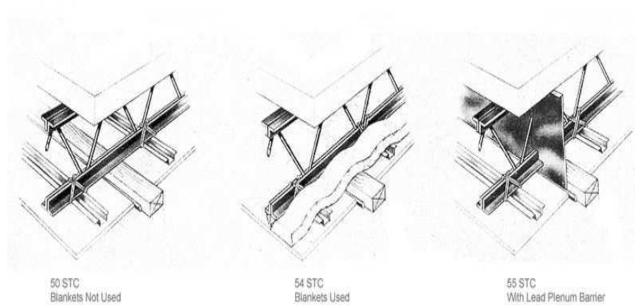


FIGURE 78

For continuous joists over a partition, double blocking above the partition to close off the plenum is recommended. The blocking should be caulked on three sides to form an airtight seal, and the ceiling interrupted at the partition if possible.

If the ceiling is suspended, it may be difficult to block off the plenum and interrupt the ceiling. However, research at United States Gypsum has shown that 1−1/2 in. THERMAFIBER Sound Attenuation Blankets laid on a interrupted, gypsum panel ceiling and extending 4 ft. on each side of the partition will provide STC 54. A similar ceiling, continuous and without wool, shoed STC−42 performance over the partition. For comparison, an expensive lead plenum barrier was installed above the interrupted ceiling and tested; it improved performance to only STC 55 (Figure 79)

FIGURE 79



Regardless off the ceiling construction, it is necessary to caulk the perimeter of the partition to prevent leaks. This is best done with a continuous bead of USG Acoustical Sealant under the edge of each base layer of gypsum panel or lath. Caulking under the runner or plate is not as effective since the sound travels under the panel, up over the runner, and out the other side (Figure 80).

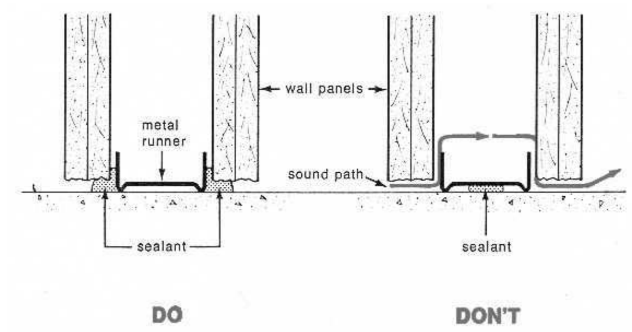


FIGURE 80

Tests by USG Research have shown that the base trim on the partition will not suffice for sealing. The performance of an STC−45 partition cailked on top and sides and with aluminum base trim was found to be STC 35. In a similar test but with caulking all the way around the partition with aluminum base trim, the performance was STC 45.USG P−1 Vinyl Trim (Figure 81), used to seal the perimeters, can be expected to perform within one or two STC points of beads of USG Acoustical Sealant.

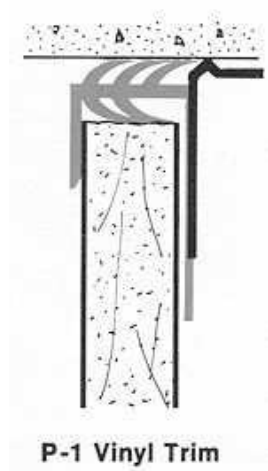


FIGURE 81
Figure 81

If a partition is to be installed over a floating floor, it is best not to support the partition on the floor. The designer should interrupt the floor and support the partition on the subfloor; seperate it from both the subfloor and the floating floor with resilient material. This will prevent sound flanking under the partition and the possibility of the partition breaking through the floating floor −− a condition which may disrupt the sound seal at the floor and pull the partition away from its seal at the top (Figure 82).

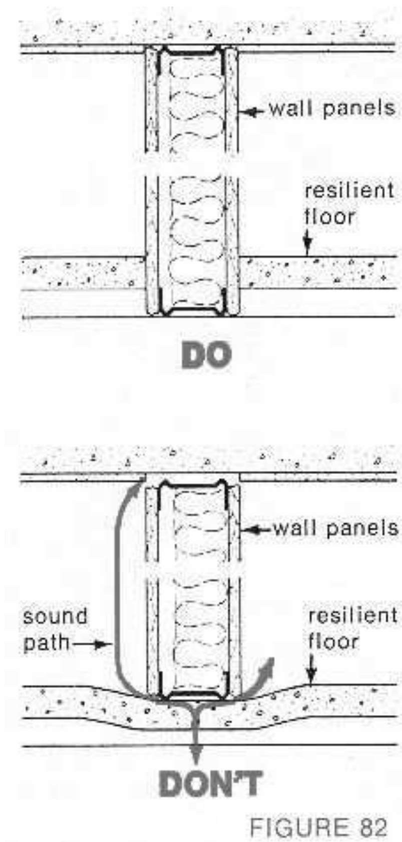
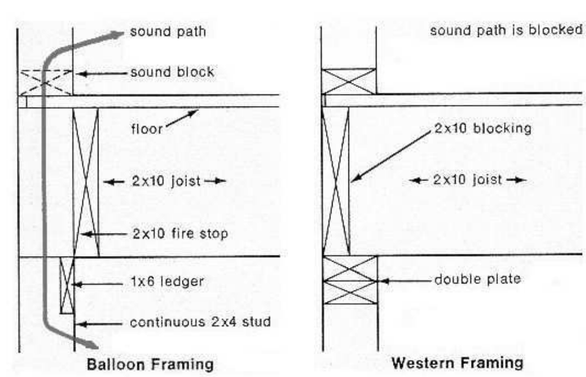


Figure 82

Similar to the flanking over a partition is the flanking that follows the outside studs on a balloon framing. Since these studs are open between floors, sound is free to enter the stud space through the wall surface and travel to either story. In single−family dwellings this is of little concern, but in multi−family dwellings it can handicap a sound−control floor−ceiling system. The solution is to block off the stud space between the occupancies or use either western or platform type framing (Figure 83).

FIGURE 83



Concrete slabs are prime carriers of flanking sound. If a party wall must be located on a concrete slab, a successful method is to provide floating floors on each side of the wall. Otherwise, the sound will enter the concrete slab and be transmitted directly under the partition to the room on the other side.

A similar situation occurs in continuous curtain walls intersected by one or more party walls. The airborne sound enters the curtain wall and follows it down to line, transmitting a clear signal into each room along the way. For correction, the curtain wall must be broken with expansion joints at each party wall.

Expansion Joints

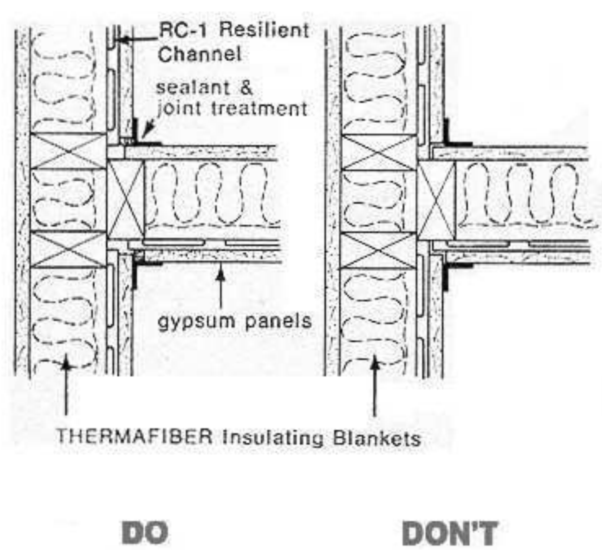
Control joints are also needed elsewhere in the construction to control thermal and hygrometric (moisture) expansion. Otherwise, the expansion and contraction may cause cracks, breaking the airtight seals. Generally, control joints should be placed every 30 ft. in continuous masonry expanses, every 50 ft. in continuous ceilings, at intersections of walls and ceilings, at the intersections of beams and partitions and at the intersection of columns and ceilings. All control joints should be structurally sound and airtight.

It is essential that surfaces to be caulked are dry and free of dust and dirt. Any foreign material present may prevent the caulking from adhering to the surfac, causing potential sound leaks.

Resilient Channels

At resilient partitions−ceiling joints, it is particularly important that the diaphragms supported on resilient channels be decoupled from intersecting diaphragms. The procedure is to cut the channels slightly short of the intersection surface and caulk as shown in Figure 84.

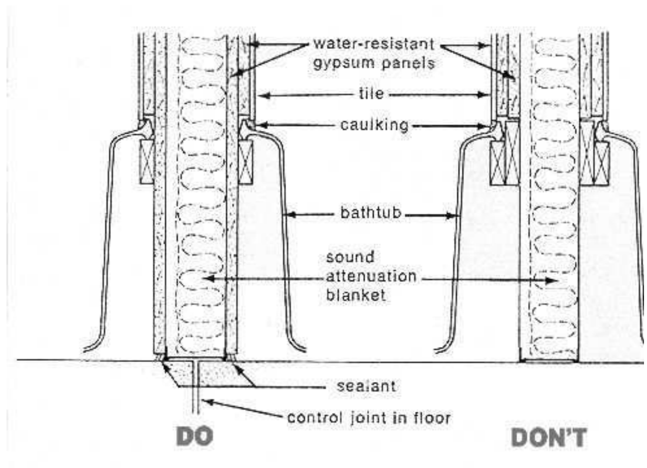
FIGURE 84



Penetrations

Some severe penetrations of the sound wall are concealed and often go undetected. An example is back−to−back bathtubs in adjoining apartments. Placed this way for economy of plumbing, the create a first−class communication system between the bathrooms. Often the tubs are installed immediately after the framing, with the gypsum panels coming later. The panels are then aplied only down to the tubs, leaving an open space from tub to tub. The solution is simple: complete the entire sound wall, including caulking, down to the floor before the tubs are installed (Figure 85).

FIGURE 85



A similar situation occurs when a stairway is attached to a party wall. Often the stairway is built and installed before the gypsum panels. Attached directly to the partition studs, the stairway produces a sound path directly into the adjacent apartment. The occupants complain that "people are walking through the living room." Stairs should be supported independently to allow space between them and the partition for normal drywall treatment; or better, the stairway should be installed after the gypsum panels have been hung, taped and caulked (Figure 86).

FIGURE 86

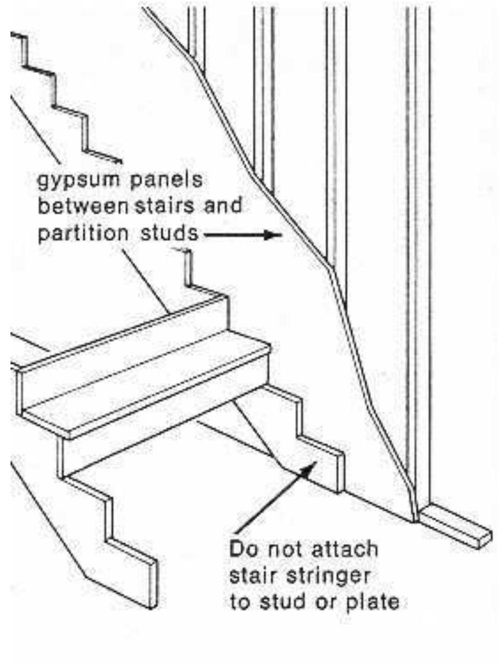


Figure 86

Other elusive flanking paths between adjoining apartments are back to back medicine cabinets (use well−hung cabinets or sheet lead between them), the open soffits above kitchen cabinets (install cabinets and soffit closure after gypsum panels are in place −− Figure 87) and exhaust fans with common ducts (use seperate ducts).

FIGURE 87

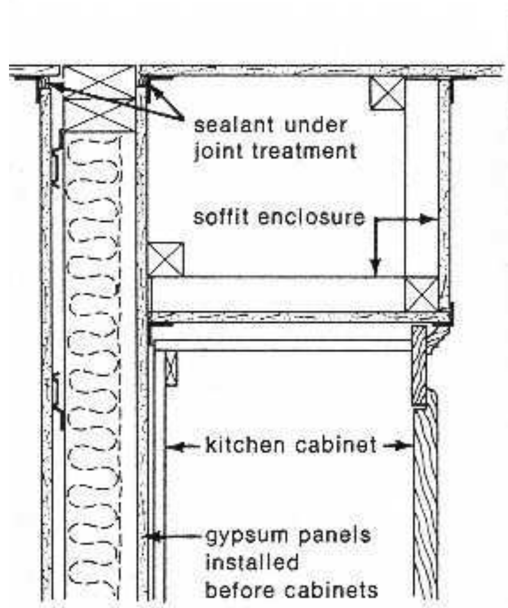


Figure 87

Doors

Doors in a sound control partition are often a difficult problem. USG Research has found that the best performance to be expected from a hollow core door without perimeter seals is STC 17. This will reduce the performance of an STC 48, 100 sq. ft. partition to approximately STC 24. A solid core door with vinyl seal around the perimeter and carpeting on the floor will reduce the performance to STC 33. For a test comparison, two inoperable solid core doors were installed in the partition with door perimeters caulked airtight; the resulting performance of STC 44 was still well below the rated performance of the partition.

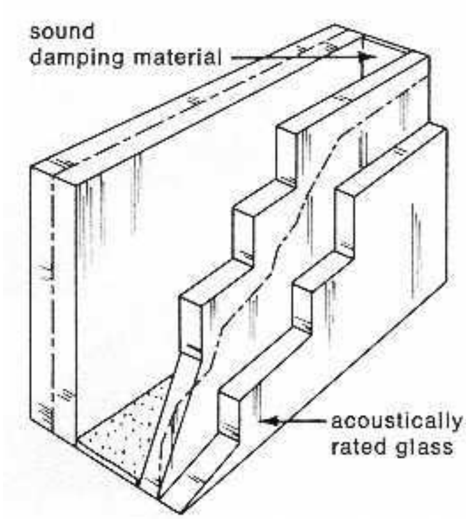
There is no single answer to this problem. A primary rule is to avoid doors in sound control partitions whenever possible. If there must be doors, solid core doors with tight perimeter seals and thresholds should be used. The swing of adjacent doors can be arranged so sound will not be reflected between them. This is particularly important in schools and offices where several doors open into a common hallway.

For added effectiveness in luxury dwellings, bathroom doors can be treated with vinyl seals and airtight thresholds in the same manner as doors in party walls are sealed.

Windows

Windows are usually not located in as critical locations as doors. If high−level outdoor sound entereing through windows presents a problem, fixes rather than operable windows may be in order; the performance of the fixed windows as shown on Figure 88 ranges up to STC 43. Ifoperable windows are essential and the situation is critical, sound locks, incorporating baffles of absorbent materials can be used. Avoid casement windows that reflect noise into the room when open.

FIGURE 88



Sound Trap Window

Figure 88

Masonry
Some sound transmission paths don't appear to be such; for instance, concrete walls of porous or lightweight aggregate transmit sound quite readlily. However, coating both surfaces with water−repellant cement base paint will improve the performance considerably. Another example is brick walls. As solid as they look, the mortar between the bricks often has tiny air spaced that let sound travel through. Plaster or drywall should be used on one side to seal these leaks if the wall is to provide sound control.

Flooring
Cracks in flooring often leak sound through an otherwise high−performance system. Tongue−and−groove subflooring or caulked joints are a remedy. In either case, the perimeters and all penetrations should be caulked to protect the performance. Subflooring should be adhesively applied for two reasons: nails transmit soundthrough the floor to the structure, and with use, nails tend to pop upm breaking through the floor covering. The resulting loose flooring will creak and thump when walked on.

Mechanical Services
In spite of the economy of back−to−back plumbing fixtures in adjacent apartments, it is better for sound control purposes to seperate them Otherwise the penetrations of the sound wall for piping, even when properly caulked, will transmit more sound than the wall. Staggering the fixtures also permits the plumbing pipes to be in seperate stud spaces an essential for sound control.

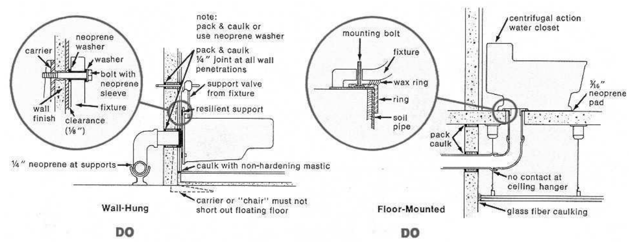
Whenever possible, it is good practice to route the plumbing, electrical and air conditioning supply lines in interiror partitions ran than in party walls. This should include separate runs to each apartment and minimum penetration of sound control assemblies. Penetrations should be as small as possible and must be caulked airtight. Runs to adjacent apartments should be atleast one stud space apart, preferably two. Vibrating appliances and equipment should connect with flexible lines on both the inlets and outlets. Typical examples are garbage disposals and dishwashers.

All services running in sound control partitions and floors must be attached to only one side of the decoupled system. For instance, if one diaphragm is attached directly to the frame and the other diaphragm is resiliently attached, services may be attached to the frame, but should not contact the resilient diaphragm. Services should not connect across staggered or double−row studs.

Resilient mounts should be used to anchor services to the structure. The most common type are clamps with a layer of resilient material around the pipe or conduit. One of the more critical installations requiring resilient anchoring is the shower riser. If not resiliently mounted, it will transmit water noise to the next apartment.

Water noise ina building can be reduced in three ways: with large pipes and valves to reduce the velocity of the water to a maximum of 7 fps; with pressure regulators to maintain the water pressure at 45 psi or below; and by providing air chambers to each outlet to cushion the shock of closing valves.

FIGURE 89



Water closets should be isolated from the floor and partitions with resilient mounts to prevent the flushing noise from carrying through the structure. Supply and waste connections should have resilient attachments, packing and caulking.

Telephones, doorbells and television antenna outlets should be placed on interior walls. Telephone and doorbells produce tremendous structure−borne sound through a party wall. The television outlets on the party wall will cause the occupants to locate the television near that wall, to the annoyance of the neighbors.

Wiring

Electrical distribution panels should be located on interior walls whenever possible. When mounted on party walls, they penetrate one diaphragm, virtueally destroying the sound attenuation performance. The panels themselves provide little resistance to sound travel.

When wiring garden apartments with one apartment above the other, the upper unit should be serviced from the ceiling and the lower apartment from the floor. This will require slightly more wire, but will eliminate the penetrations between apartments.

On party walls, electrical obxes for adjacent apartments are best located atleast one, and preferably two, stud spaces apart to connect with seperate conduit leads. Tests by USG Research have shown that the performance of an STC 50 partition will be reduced to STC 41 by back−to−back electrical boxes, and only come up to STC 48 when boxes are completely caulked. If the conduit connects with two resilient surfaces, it shoud be flexible and installed loosely with resilient clamps. Conduit acts as a sound tube between outlet boxes.

Electrical outlet boxes with perforations or loose knockouts have no place on soun walls. Electrical boxes should be caulked on all sides and between the box and wall panel. Caulking is available in tape form for the backs of the boxes, and USG Acoustical Sealant is ideal for caulking around the opening. The outlet box should be absolutely airtight when completed.

Equipment Recommendations

- Provide external ballast on flourescent light fixtures; select balasts for their quiet operation.
- Install all electrical vibrating equipment in resilient mounts, connected with flexible conduit. Typical examples are exhaust fans, electric motors, washers, dryers, dishwashers and garbage disposals.
- Provide individual outlet ducts for exhaust fans. Place exhaust fan ducts on exterior rather than party walls.
- Recessed light fixtures penetrate the ceiling diaphragm and thereby jeopardize the performance of the floor−ceiling construction. If used, they should be caulked airtight, backed with sound attenuation blankets and mounted on framing in common with the ceiling diaphragm. The fixture mounting must not connect the resiliently mounted ceiling to the rigid structure. Electrical leads to the fixture should be long, flexible conduit (Figure 90).

FIGURE 90

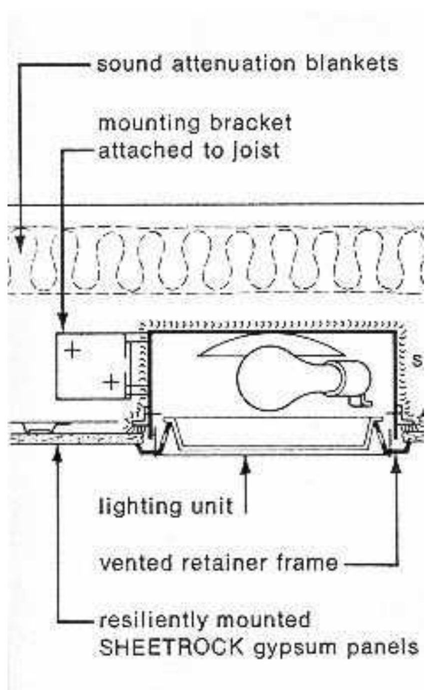
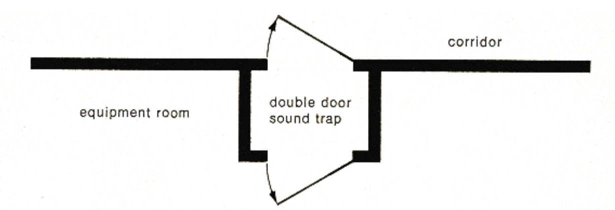


Figure 90

- Isolate all heating and air conditioning equipment from the structure with resilient mounts. In larger installations, this may require the use of spring−mounted inertia blocks to localize the vibration. Ducts and blowers should be designed for high volume and low velocity (a maximum of 1600 fpm at the fan outlet and 700 to 900 fpm in the main ducts). Blowers should be well balanced for quiet operation. Use long, flexible service leads to the equipment.

- Decouple air ducts from the blower equipment with a canvas or other resilient boot at the plenum. Attach all ducts to the structure with resilient mounts. In most cases resilient material under the banding is sufficient to isolate the ducts.
- Use separate supply ducts to each apartment. Space ducts at least one stud space apart. Otherwise, sound will cross from one duct to the other through the acoustically transparent duct metal. Ducts running between joists should also be one ore more joist spaces apart.
- If common ducts are used between occupancies, they should be fitted with sound−absorbing duct liners extending atleast 3 ft. past the first turn from each room. These will provide only a degree of privacy if the runs between the apartments are short. Return air ducts should be handled with the same care and treatment as the supply ducts. Liners may also be necessary on the returns.
- The mechanical equipment room in a large building is potentially a major noise source, capable of sound levels from 75 to 105 db. In addition to the impact sound created by the equipment, a great deal of airborne sound will be produced. Sound control construction is recommended on all sides. If possible, locate the entrance from the exterior of the building to avoid penetrating the enclosure. Otherwise, use a sound−trap entrance cosisting of a short all with sealed double doors (Figure 91).

FIGURE 91



- Since most of the services will penetrate the sound control enclosure of the equipment room, be sure adequate (airtight) caulking is provided at the cutouts.
- Don't install door knockers in multi−family dwellings. Impact sound created by these knockers is not only annoying, but confusing − residents cannot determine who has the callers.

Absorption Materials

Absorption materials can be used liberally in noisy areas to absorb sound before it is transmitted into other areas. This is particularly important in bathrooms, kitchens, hallways, and stairways. While carpeting in kitchen and bathroom floors is still somewhat of a novelty, it is beneficial in sound control. The indoor−outdoor carpeting now available for these areas will undoubtedly increase in usage.

Maximum acoustical treatment in stairways and corridors of multi−family dwellings is justified. The annoying impact of footsteps can be softened with carpeting, while acoustical treatment of the ceiling will quickly absorb much of the conversation and commotion. High−performance sound control assemblies on all four planes of te corridor will then successfully isolate the remaining noise.