40 Mechanical (HVAC)*

The mechanical subcontractor (more commonly referred to as the heating, ventilation, and air conditioning, or HVAC, subcontractor) will furnish and install all equipment, ductwork, and piping for the systems that regulate air movement and modify the ambient temperature. As with all MEP systems, HVAC systems are complex, so this discussion will focus on the coordination of subcontractor scopes of work and not on the intricacies of each different type of HVAC system. Following are some basic examples of the most common of the myriad of HVAC systems that might be encountered.

A. Air handling units with variable air volume (VAV) terminal boxes are standard on many non-residential construction projects (Figure 40.1). This type of system includes a hydronic boiler system that is provided by the HVAC subcontractor. The plumbing subcontractor will provide only a single point of connection for supply water to this system, i.e., the HVAC subcontractors have their own pipe fitters (Figure 40.2).
   (a) In a union setting, their formal training is somewhat different, but pipe fitters for hydronic piping systems share the same union with plumbers. In fact, these workers can be employed in either trade. In practice, pipe fitters rarely perform plumbing work and plumbers rarely perform pipe fitting work. It would otherwise seem intuitive to someone new or unfamiliar with the construction industry that these trades are one and the same.
B. Residential projects, such as mixed use, condominiums, or apartment buildings, will most commonly have split systems for heating and cooling. These split systems consist of a fan coil within the ceiling or a closet and a condensing unit on the roof.
C. The HVAC subcontractor will provide all exhaust systems (Figure 40.3), including the following:
   (a) Restroom exhaust that must have its own dedicated duct system and exhaust fan, due to potential odors.
   (b) Laundry exhaust, due to lint collection, will also have its own ducting (with integrated lint traps) and exhaust fan.
   (c) Commercial kitchen exhaust from the range and other greasy cooking areas will be designed as an isolated system because of the accumulation of grease in the ductwork.

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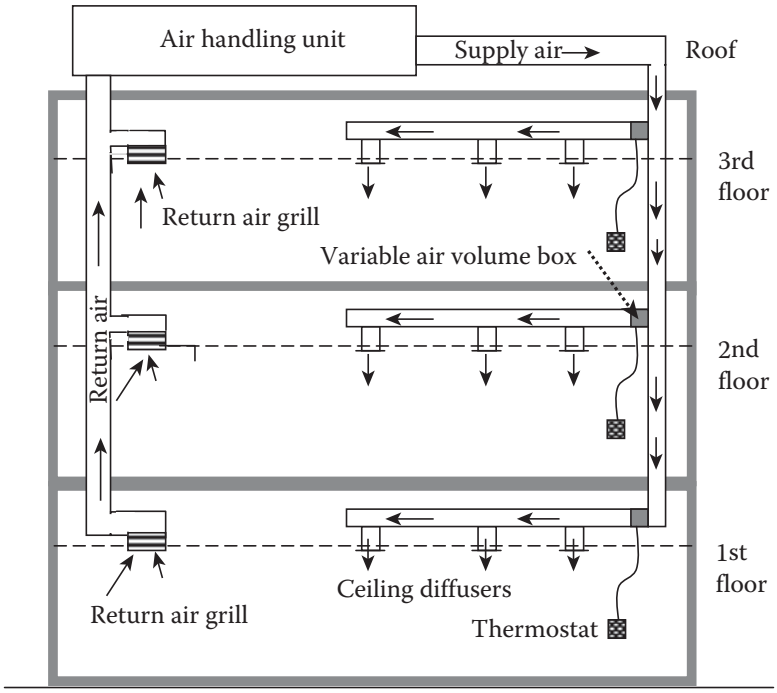

FIGURE 40.1 HVAC system.

FIGURE 40.2 Hydronic piping at an air handling unit (AHU). (Photo by author, courtesy of Hathaway Dinwiddie Construction Company and California State University Northridge.)

(d) Parking garage exhaust is also routinely designed as a stand-alone system.

D. Radiators and radiant heating will be provided by the HVAC subcontractor with their hydronic piping crew. Although this system involves a considerable amount of piping and does not move air, it does control the air temperature. Therefore, it is not the plumbing subcontractor's work as is often confused.

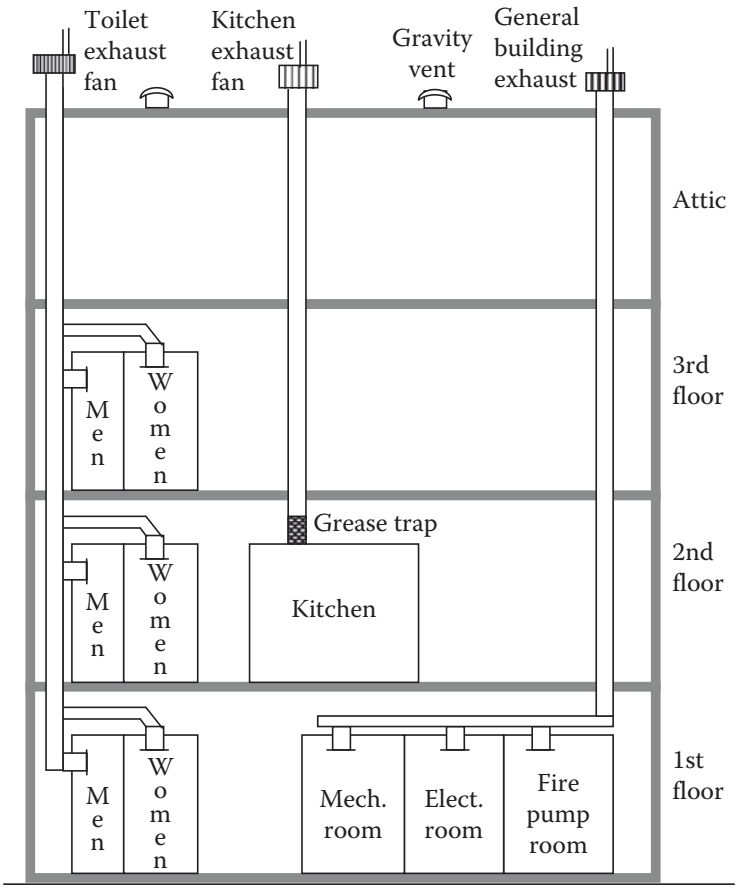

FIGURE 40.3 Building exhaust.

This is not a complete list of the systems an HVAC subcontractor can provide, but it is a good sampling of their responsibilities. When determining if work is to be performed by the HVAC subcontractor, a basic rule can provide guidance: if the system moves air, permits the movement of air, or has a primary purpose of conditioning the air temperature, it is most likely the HVAC subcontractor's work. There are few exceptions to this rule.

SCOPE OF WORK ISSUES RELATED TO MECHANICAL (HVAC)

1. The HVAC subcontractor will commonly be responsible for obtaining the mechanical permit from the building department. As with the plumbing permit, the HVAC subcontractor will also be responsible for paying for the permit if stated in the contract documents.
2. HVAC work involves a significant amount of low-voltage controls work. The HVAC subcontractor normally provides the low-voltage controls work via their own specialized lower-tier low-voltage electrical subcontractor. These controls can be simple, such as in a condo tower where most controls are simply wall-mounted thermostats tied to their respective fan coil. They can also be quite complex, such as for a high-end commercial building where each piece of equipment, VAV terminal box, temperature

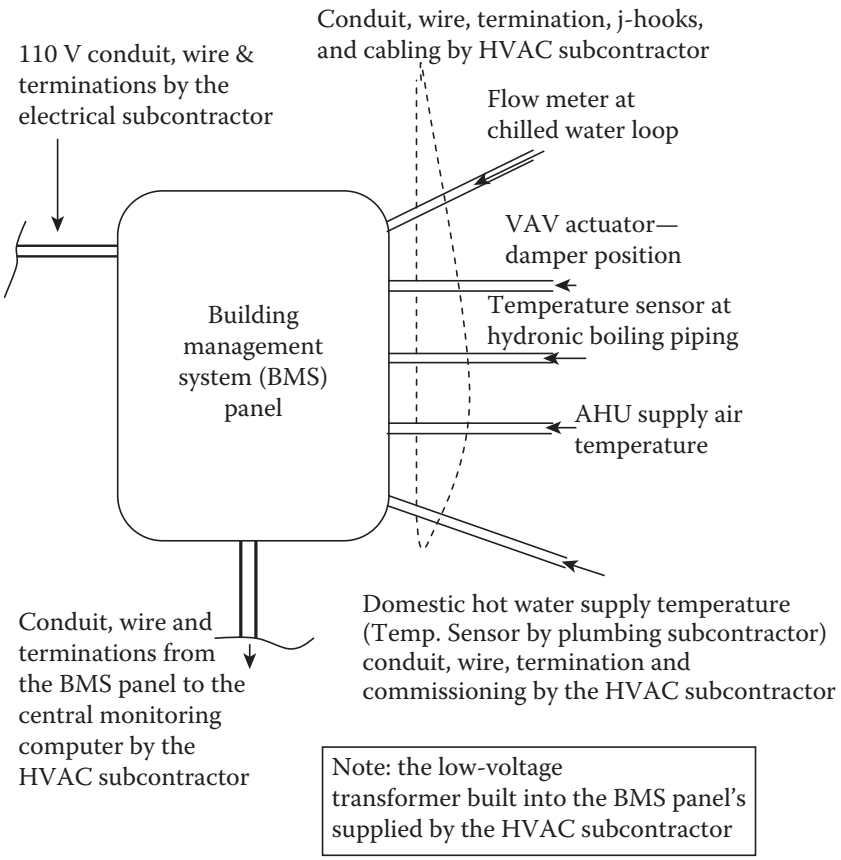

FIGURE 40.4 Building management system.

gauge, zone thermostat, air flow sensor, pressure sensor, and so on will be wired to a central computer called the building management system (BMS) (Figure 40.4). The BMS allows the building maintenance staff to monitor, and sometimes control, the HVAC systems remotely. This expensive management system is particularly common and useful for large campuses such as at universities and major industries.

(a) Note that systems of other subcontractors, such as generators, domestic water pumps, and elevators, are also commonly monitored by the BMS system. The sensors and control points for these non-HVAC systems will be furnished and installed by the subcontractor responsible for the respective system. Then the HVAC subcontractor will provide conduit, wire, and terminations to tie these points into the BMS system, as well as program the BMS system to recognize these points. Naturally, commissioning of these points will be a joint effort.

3. In a high-end commercial building with significant controls work, various methods may be encountered for connecting 110V power to the VAV terminal boxes and fire smoke dampers (FSDs). Traditionally, the electrical engineer will indicate power to each VAV box and FSD, with the power being provided by the project's electrical subcontractor. This is the most common method of design and construction. The electrical engineer may also take advantage of the fact that the HVAC subcontractor will have their

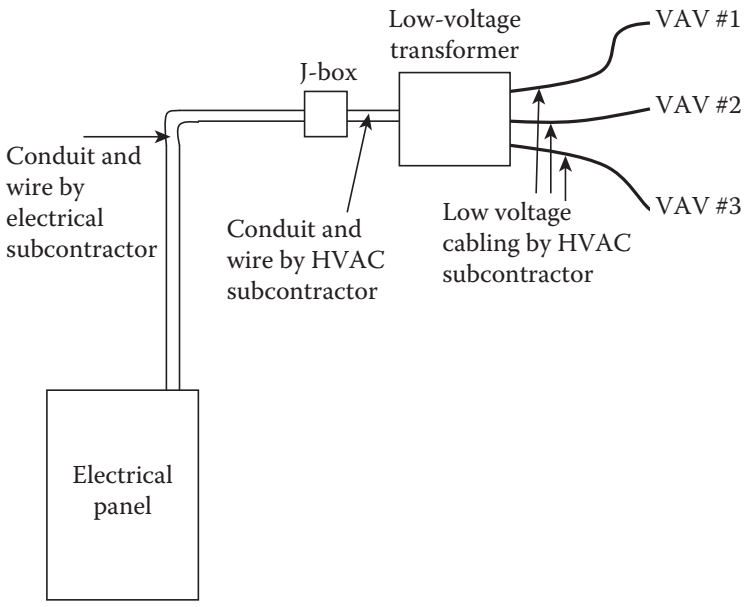

FIGURE 40.5 Power to VAVs and FSDs.

own lower-tier electrical subcontractor for controls. They may simply show an electrical circuit serving multiple components being brought to a central location and terminated in a junction box (Figure 40.5). The controls subcontractor would then be responsible for distributing the power from that point to each component. Electrical engineers may take this approach because MEP coordination is the general contractor's responsibility. In this coordination effort, VAV boxes and FSDs are commonly relocated. The electrical engineer will be cautious about indicating points of connection that the general contractor will later change in fear that these changes will be the genesis of change order requests. It is important to review how the power for VAVs and FSDs has been designed to ensure the divisions of work are properly covered by the bidders.

4. Commissioning of the HVAC system is described in most specifications as being performed by a third-party commissioning firm not affiliated with the HVAC subcontractor. Most large HVAC subcontractors have a wholly owned subsidiary firm that performs commissioning work. HVAC subcontractors commonly use this subsidiary as their third-party commissioning agent. The fact that this company is not a true, unbiased third party is rarely noticed. When this is discovered, the project team typically takes no action. It is recommended that the project team keep the subcontractors in full compliance with the contract documents. As such, they should disallow the use of subsidiary commissioning firms. Make note that subsidiary firms are often given a completely different name than the parent company, specifically so the association with the parent company is not readily apparent.
5. Wherever a low-voltage circuit begins (typically at independent control panels and control panels integral to equipment), a step-down transformer will be required. This will convert the 110V power provided by

the electrical subcontractor to a lower voltage, commonly 24V. These step-down transformers often come as part of the independent control panels and control panels integral to the equipment, but not always. If not specifically addressed in the subcontractor's scope of work, both the electrical subcontractor and HVAC subcontractor may exclude furnishing and mounting these transformers when they are not factory-installed in the control panels. It is best that the HVAC subcontractor provide these transformers for two reasons. First, the HVAC subcontractor is most informed about which step-down transformers are already included as integral parts of the equipment and which need to be furnished separately. Secondly, the HVAC subcontractor will at times custom fabricate the independent control panels. They must fabricate these panels with sufficient room to accommodate the step-down transformer inside; otherwise an auxiliary wall-mounted box will be necessary to house the small transformer. This eliminates the coordination issue and the necessity of the additional system component by requiring the HVAC subcontractor to mount these transformers in the shop.

6. Air handling units, exhaust fans, and other equipment are commonly designed to run at variable speeds by means of a device called a variable frequency drive (VFD) (Figure 40.6). Like control panels and step-down transformers, Variable frequency drivers (VFDs) are sometimes integral to the equipment and are factory-mounted, but sometimes they are furnished and installed separately. It is best to have the HVAC subcontractor furnish and mount the VFDs on or adjacent to the respective equipment. Since the electrical connection will be no less than 110V (quite often 460V), the electrical subcontractor must provide all conduit, wire, and terminations from the VFD to the equipment, in addition to their obvious work of bringing power to the VFD. The electrical subcontractor will assuredly pick up the

FIGURE 40.6 Variable frequency drive (VFD). (Photo by author, courtesy of Hathaway Dinwiddie Construction Company and The California Institute of Technology.)

conduit, wire, and terminations in their base bid, but furnishing and mounting the VFD is a common exclusion by both of these subcontractors. The general contractor must make sure that both furnishing and installing the VFDs is properly covered in the bids.

(a) Mechanical equipment manufacturers do not commonly allow anything, including VFDs, to be screwed into their equipment in the field. To do this could diminish or completely void the warranty. If there is no wall immediately adjacent to the electrical point of connection, the HVAC subcontractor will need to provide a floor-mounted post or rack for the VFD. This is an important inclusion in the scope of work. For example, the HVAC subcontractor may argue that this mount is not in their scope and insist on simply mounting the VFD on the closest available wall, which could be twenty or thirty feet away. This would add considerably to the conduit and wire provided and routed by the unsuspecting electrical subcontractor. It is suggested that the HVAC subcontractor be contractually required to mount the VFDs within six feet of the equipment point of electrical connection.

7. Duct smoke detectors will be furnished by the fire alarm subcontractor FOB jobsite to the HVAC subcontractor. The HVAC subcontractor will mount the smoke detectors in the ductwork and provide an access door in the duct for access by the fire alarm subcontractor. The electrical subcontractor will provide the conduit and the fire alarm subcontractor will complete all wiring, terminations, and commissioning of the devices.
8. The HVAC subcontractor will provide all conduit, wiring, terminations, and commissioning for all controls circuits interconnecting the HVAC system to peripheral devices. An example of a peripheral device would be the make-up air for a fireplace as discussed in the chapter on miscellaneous specialties. When a fireplace is burning, the combustion depletes the oxygen in the room and sends air up the flue; therefore, make-up air must be provided. This make-up air is not necessary if the fireplace is off. Thus, a controls circuit from the fireplace to the HVAC system is necessary for the make-up air to run when the fireplace is on and to stop when the fireplace is off. This circuit will be completed by the HVAC subcontractor, but, naturally, the fireplace subcontractor will collaborate with the HVAC subcontractor in commissioning this circuit.
   (a) Fume hoods are another example of a peripheral device requiring interconnection. They will require variable levels of make-up air, depending on the height to which the sash is raised.
9. Parking garages regularly use a carbon monoxide (CO) detection system to control the garage exhaust fans. These detectors are spaced throughout the garage. When one detector senses that the CO level is above the preset limit, it signals the exhaust fan to turn on (Figure 40.7). Responsibility for the controls conduit, wire, and terminations for this work will vary by project. It is most typical for this scope of work to be allocated to the HVAC subcontractor. For a project with no significant HVAC controls it is more appropriate for the electrical subcontractor to provide the conduit, wire,

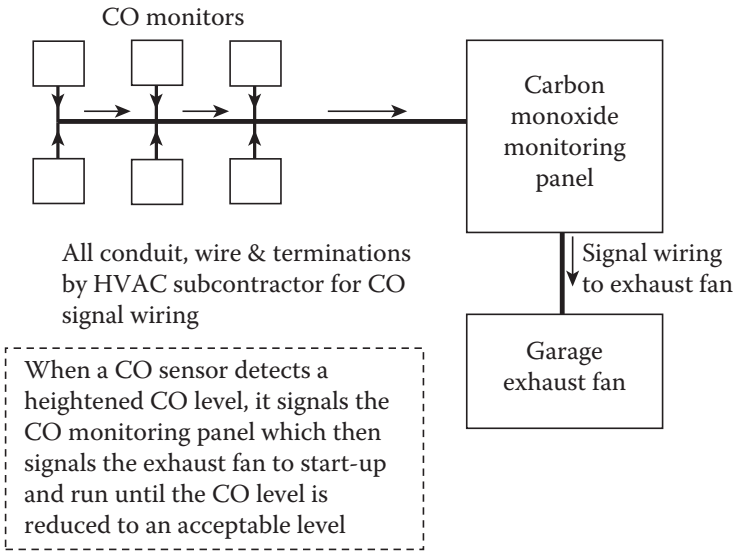

FIGURE 40.7 Carbon monoxide detection system.

and terminations for this system because the HVAC subcontractor will not have a lower-tier low-voltage electrical subcontractor readily available on the project. The HVAC subcontractor will always be responsible for commissioning this system.

(a) As a general rule, for a smaller project with few HVAC controls circuits the general contractor should consider allocating the HVAC controls circuits to the electrical subcontractor to avoid a lower-tier electrical subcontractor being employed by the HVAC subcontractor for only one or two days' worth of work.

10. The HVAC subcontractor will perform their own hydronic piping work. On a union project, the union jurisdiction will dictate that condensate piping is a drain and because plumbers claim all drains, it is to be performed by the plumbing subcontractor.
11. Large equipment (such as chillers, water storage tanks, and air handling units) located inside the building must be procured early in the project if they are too large to travel through the building once the walls are constructed. This equipment will require expedited procurement and significant protection while stored in place during heavy construction activities. Be sure this expedited procurement is clearly defined in the project schedule, bidding instructions, subcontract agreement, and expediting plan. Late delivery of such large equipment is a common cause of delay to interior framing, CMU, and exterior wall activities. The subcontractor providing the equipment (the HVAC subcontractor for this example) should always be responsible for providing protection of their own equipment, as well as the eventual removal and disposal of the protection materials. This protection should be sufficiently adequate to require no maintenance throughout the construction duration. (Note the disparity in responsibility between protection of large equipment versus protection of finishes, such as carpeting. In the case of building finishes the protection is provided by the respective

subcontractor, but maintenance and removal of the protection is actually performed by the general contractor.)

(a) Equipment is only situated at inaccessible locations if there are no viable accessible locations. This is not a major concern for owners because large mechanical equipment is generally very reliable. Large equipment commonly has a 30-year or longer expected lifetime and, when necessary, malfunctioning parts can be repaired or replaced without replacing the entire unit. Owners often recognize that when it is time to replace major equipment in the distant future that the building will be in need of a major renovation. The equipment replacement can be timed to occur along with the renovation work.

12. The HVAC subcontractor should be held responsible for furnishing and installing all roof flashings for their own work. This includes roof jacks, flashing from equipment over curbs (Figure 40.8), and flashings required for duct penetrations (Figure 40.9). The HVAC subcontractor must also provide all sealants related to these flashings, maintaining full responsibility for waterproofing protection of their penetrations through the roofing membrane.

(a) The flashing subcontractor is capable of completing flashings around ducts and equipment. Nonetheless, it is in the best interest of the project to keep responsibilities for the waterproofing integrity with the party that makes the roof penetrations. While there are exceptions to this general rule as discussed in various portions of this book, this approach greatly helps to avoid problems enforcing warranties in the event of a leak. The precise source of a leak is difficult to determine, so if the HVAC subcontractor installed a duct through a roof curb, the flashing subcontractor provided the sheet metal flashings from the duct over the curb, and the caulking subcontractor sealed the flashings, none would readily accept responsibility. Such warranty problems are common when multiple subcontractors are involved. If only one party is involved, the warranty is easily enforced. If more than one

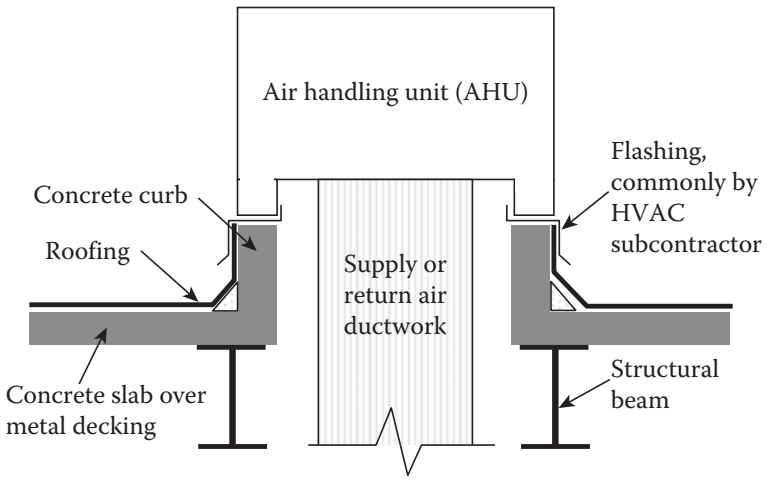

FIGURE 40.8 Cap flashing at equipment pad.

FIGURE 40.9 Duct flashing at roof. (Photo by author, courtesy of The University of Southern California.)

party holds responsibility for a warranty, the reality is that there may be no enforceable warranty.

13. The HVAC subcontractor will install the trash chute and furnish all mounting hardware that is not otherwise provided by the chute manufacturer. The intricacies of the trash chute divisions of work are described further in the chapter on miscellaneous specialties, but there are additional items worth noting in this HVAC discussion:
    (a) Assume that the trash chute manufacturer will provide mounting brackets for a 24″ diameter chute (24″ diameter is the most common size chute). These brackets are commonly only capable of spanning a 27″ × 27″ floor blockout. Trash chute installations typically consist of two chutes side-by-side (one for trash and one for recycling). A common problem occurs because this is often shown on the architectural drawings as a single large blockout, in lieu of two individual blockouts, and much wider than 27″. If the floor openings are too large for the manufacturer-supplied brackets, supplemental supports will be necessary and the HVAC subcontractor will assuredly submit a change order request for the additional work required to mount the chutes. The proper size of these floor openings may vary slightly from manufacturer to manufacturer, so the actual dimensions must be confirmed and coordinated by the general contractor.
    (b) Trash chutes do not always come standard from the manufacturer with a rain cap. If this rain cap is excluded in the chute manufacturer's bid, it can easily be provided by the HVAC subcontractor, as long as they are notified during the bidding phase.
14. Secondary drain pans (Figure 40.10) will be required at locations shown on the drawings, such as below fan coils above gypsum board ceilings. Additional secondary drain pans may also be necessary due to the general

FIGURE 40.10 Secondary drain pan. (Photo by author, courtesy of Hathaway Dinwiddie Construction Company and The University of Southern California.)

contractor's means and methods, such as under piping in an electrical room. While the actual dimensions may vary from jurisdiction to jurisdiction, piping cannot be run above electrical gear within a specified lateral distance (stated in feet) of the gear. It is always best to route wet utilities around electrical rooms, but at times the only possible route for piping (whether it be plumbing, hydronic, or fire sprinkler) might be through the electrical room. A secondary drain pan will be required underneath this piping so that if a leak does occur it will be caught in the pan. These drain pans are sloped to drain in one corner at which point a screwed fitting is provided where the plumbing subcontractor will connect a drain line. While the secondary drain pans required as a result of the contractor's means and methods will not be shown on the construction drawings, a thorough pre-bid review of the MEP documents will provide the general contractor with a good estimate of the required number of these items. The general contractor must then inform the subcontractors of this additional work in the bid instructions.

(a) Note that secondary drain pans can be furnished by either the flashing or HVAC subcontractors at the general contractor's discretion.

(b) There may not be a building drain that can be reached by sloping the pipe to the drain. In that event, a small pump (similar to the fan coil condensate pump discussed in the chapter on plumbing) will be required. If a pump is required it should be furnished by the plumbing subcontractor, coordinated with the HVAC subcontractor, and powered by the electrical subcontractor. Again, for secondary drain pans added as a result of the general contractor's means and methods, this work must be identified and clearly conveyed to the bidders in the general contractor's bid instructions.

(c) While all piping mains may be able to route around the electrical rooms, this will always be an issue for fire sprinkler piping. It is

unavoidable that fire sprinklers will be located in the electrical room. Quite often sprinkler piping can be routed through the room while avoiding the prohibited space above and around the electrical gear. This may be done by entering the electrical room above the door (there will be no electrical gear in front of a door). Then route the sprinkler piping through the middle of the room, as far away from the electrical equipment as possible. Successfully routing the piping away from the electrical gear is largely dependent on the size, shape, and configuration of each individual electrical room. The pipe routing must be analyzed for each individual project.

15. Louvers on a building have a significant aesthetic value. These louvers, commonly termed architectural louvers, will most commonly be provided by the flashing subcontractor. At the general contractor's discretion, when there are only a few architectural louvers and they are all related to the HVAC work, they can be efficiently allocated to the HVAC subcontractor. Architectural louvers are usually located at the exterior walls, are easy to identify on the building elevation drawings, and have their own specification section in Division 10. This makes it easy to identify, quantify, and allocate this work.
16. The HVAC subcontractor will furnish and install flues from gas-fired equipment such as water heaters, boilers, and fireplaces complete.