Installation of VAV Diffusers

Stay true to the intent of the designer

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VAV diffusers are installed the same way as standard diffusers. They can be laid-in, cut into the ceiling construction, or installed on exposed ductwork (Figure 1). Like standard diffusers, the balancing damper should be located at the take-off from the trunk duct, although this is less critical as VAV diffusers operate at lower pressures. Electrically actuated VAV diffusers will require a 24-v power supply. Always refer to the manufacturer's installation instructions for specific requirements.

The thermostats of most VAV diffusers are factory-set at a comfortable temperature. Because loads in various spaces differ, as do individual preferences, a few days of operation after startup should be allowed before changing the thermostat set point.

Occasionally, VAV diffusers are factory-fitted with a ceiling plenum bypass at the inlet. Care should be taken to avoid interfering with the bypass operation when connecting the supply-air duct.

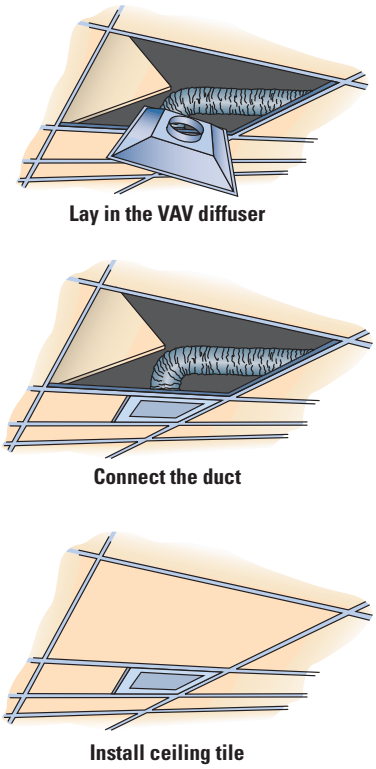

FIGURE 1. Steps to install a VAV diffuser.

LOCATION

Under certain conditions, diffuser location needs to be carefully reviewed. Because many VAV diffusers have a built-in thermostat that controls room temperature by sensing the secondary room air induced upward in the center of the room, care should be taken not to disturb room air induction and entrainment. For example, locating diffusers within 2 ft of walls, dropped lights or any other protrusion from the ceiling may result in reflection of primary air back under the VAV diffuser, thus providing inaccurate room-temperature sensing. This can be resolved by relocating either the VAV diffuser or the protrusion or by modifying the VAV diffuser to a three way blow pattern.

VAV diffusers have high discharge velocities, which can be deflected downward by protrusions below the ceiling such as lights or beams beyond 2 ft away. To avoid down drafts, care should be taken to install VAV diffusers away from such protrusions (Figure 2). VAV-diffuser installations provide satisfactory air-distribution results because VAV diffusers have such high discharge-velocities. Typically, a drop no more than 1 ft at the 50-fpm throw distance is expected.

Locating a return in each space with a VAV diffuser is also necessary to achieve individual temperature control.

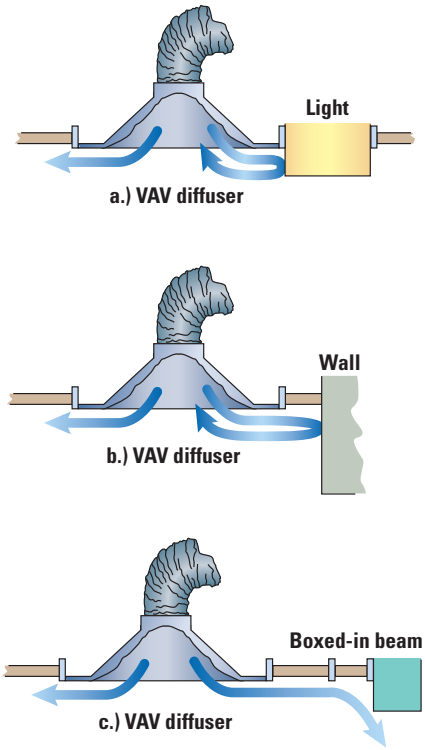

FIGURE 2. Avoid installations like these.

DESIGNER'S INTENT

It is important to carry out the intent of the designer when installing a system for VAV diffusers. Two of the three design considerations discussed in the previous article (February 2001) involve the system. The first of these is to control for an almost constant supply-air temperature. The system controls should accomplish this by controlling the supply-air temperature from a discharge air sensor.

The second system-design consideration is maintaining a static pressure at the VAV diffusers below 0.25 in. WG but high enough for design air flow. Installers should avoid any modification of the original system design, which results in higher static pressures or increased pressure drop in the ductwork.

CONCLUSION

VAV diffusers install the same as standard diffusers. Care should be taken with anything that could block the air flow away from the diffusers, which would disrupt sensing and deflect flow. Carry out the designer's intent for supply-air-temperature control and static -pressure control.

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Installation considerations for automatic sprinkler systems

Common mistakes and how to avoid them

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Just as there are standardized rules pertaining to the design of automatic sprinkler systems, there are also standardized rules pertaining to the installation of those systems. The field installation phase can be a much more challenging undertaking than the design process. No matter how meticulous the design process, poorly installed components will result in a system that, to the untrained eye, looks like a functional system, but may not perform well enough to control an actual fire. This article provides insight into some of the more practical considerations that will allow a system to perform as the designer and the code intended.

FIGURE 1. Sprinkler head installed too close to the wall.

RULE NO. 1

The quality of an installation is determined by the quality of the installer. Before the first section of pipe is hung, the knowledge, experience, and conscientiousness of the installation crew determines the quality of the installation. Misapplication of the rules for spacing, locating, and positioning of sprinklers can render a system to nothing more than hanging pipe. In certain applications, the designer may have chosen to use plastic pipe. In addition to the standard rules of installation, plastic pipe requires specific attention to the method of joining pipe and the use of hangers. This writer knows first hand of an installation where the installation crew foreman used a super glue-type substance in an attempt to stop joint leakage prior to a hydrostatic test.

To ensure that the installers are knowledgeable and experienced, request references from previous clients. Many authorities having jurisdiction (AHJs) require that sprinkler systems be designed by a certified professional (a registered professional engineer or technician), but very few jurisdictions require certification for installation crews. I have seen jobs in which the installers were picked up from a temporary manpower agency each morning and brought to the job in a company truck. With over 4,000 sprinkler heads and miles of piping already behind drywall, no one knew the difference until field quality checks by a qualified fire protection construction manager began to turn up numerous installation violations. The cost of upgrading the system to minimum standards was in the tens of thousands of dollars.

THE GUIDING PRINCIPLES

Satisfied that your installers are experienced and knowledgeable, there are several guiding principles upon which NFPA 13 bases its installation criteria. These principles, shown in Table 1, are based on the fact that NFPA 13 addresses protection for both life safety and property protection purposes. In some cases, these principles can result in conflict with other regulations. Where conflicts arise, the AHJ should be consulted during the design phase to help ensure that the field installation will be acceptable.

Section 5-5 of NFPA 13, *Position, Location, Spacing and Use of Sprinklers*, specifies in detail the manner in which the guiding principles are to be field-implemented. As with most rules, there are exceptions to sprinkler-installation rules. NFPA 13 is clear as to when and how exceptions can be applied to the rules of installation.

Basic Principles

for spacing, location, and position of sprinklers

1. Sprinklers shall be installed throughout the premises.
2. Sprinklers shall be located so as not to exceed the maximum protection area per sprinkler.
3. Sprinklers shall be positioned and located so as to provide satisfactory performance with respect to activation time and distribution.

THE BASICS

Along with the technical rules for installation found in NFPA 13, the following basics should be observed:

Common Sense. The basic rules for sprinkler system installation usually require the application of common sense as much as technical rules. For example, indicating control valves are required to be located in an "accessible location." Typically, valves installed at ceiling level or in closets are not accessible; neither are valves installed above gas fired heating appliances. Another condition that should raise a red flag is when a sprinkler head is installed within 4 in. of a wall, as illustrated in Figure 1. NFPA 13 prohibits this condition because it can impact the proper activation of the sprinkler. While installers are not designers, ideally, they should be able to recognize situations where the plans call for installations that don't make sense in the field.

Coordination. Many times, changes have to be made as a result of a lack of coordination among the trades. For example, before hanging any pipe, the installation foreman should know where the HVAC duct is to be run. An agreement as to what trades run high and what trades run low is essential

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in avoiding conflict in equipment location. Unexpected structural modifications to the building during construction can also require that the sprinkler installation be adjusted. The installers should be aware that these changes can impact the performance of the system and should notify the designer so that any design modifications can be made.

A good example of a lack of coordination involved sidewall sprinklers and a set of smoke doors in the corridor of a retirement home. Using the original architectural drawings, the sprinkler contractor installed sidewall sprinkler heads on both sides of the frame location for the smoke doors. When the doors were set, it was decided that they should be set 4 ft further down the corridor. The result was that the door now had two sprinkler heads, spaced 4 ft apart, on one side of the doors. This condition was not picked up by the sprinkler contractor or the construction superintendent. The problem was identified when I was asked to perform a quality review of the sprinkler system after the building was completed.

Proper use of materials. For the sake of quick installation, I have seen cases where materials were improperly used. For example, NFPA 13 and manufacturers' literature specifically state that plastic pipe is not to be used on a dry system, yet I have seen an attempt to use plastic pipe to make up short branch lines in a dry system. In an even more blatant disregard of the rules, I have seen sidewall heads installed in the pendant position in a finished ceiling. Sprinkler heads are not universal in their use. They are approved for use under very specific conditions. Proper use of pipe hangers and sway bracing must also be evaluated. Plastic pipe has specific requirements for piping support. Additional bracing must be installed as specified by the manufacturer.

Install it all. Particularly on rush jobs, I have seen instances where parts of the system were not installed. Examples include incomplete risers, incomplete branch lines, no inspector's test connection, alarm switches installed on the system but not electrically connected, hose stations with no threaded connections, missing sprinkler heads, missing auxiliary drains, and insufficient hangers.

Attention to detail. The quality of the installation will show up in the details. Things to look for are risers installed on vertical, sprinkler heads installed with frame arms parallel to the piping, sprinkler heads that seat properly with ceiling tile, sprinkler heads not blocked by obstructions, hangers suspended vertically, auxiliary drains properly installed, and correct temperature sprinkler heads installed for the application.

A WORD FROM THE UNDERGROUND

Often taken for granted, a sprinkler system will be no more effective than the reliability of the water supply. When there is a separate underground water main installed for the sprinkler system, proper installation will ensure its viability. The major issues with underground pipe involve depth of bury, proper joining of sections, and adequate thrust blocking. Except for the case of welded joints and approved special restrained joints, the usual joints for underground pipe are expected to be held in place by thrust blocks and the soil in which the pipe is buried. Gasketed, push-on, and mechanical joints without special locking devices have limited ability to resist separation due to movement of the pipe.

Concrete thrust blocks are one of the most common means of restraining underground pipe. NFPA 24 contains detailed information on the proper design of thrust blocks. However, rarely have I seen a correctly designed thrust block properly formed and poured. Most installations look as if a batch of concrete were mixed in a wheelbarrow and dumped over the embankment onto the pipe joints and sloshed between the joint and the earth behind it. The thinking behind this method is that enough concrete will hold anything in place. However, this sloppy method usually covers the joint such that detection of water leakage during the required 2-hr hydrostatic test is virtually impossible.

SUMMARY

A well-installed system will expedite the final acceptance by the AHJ. A system in which little attention to quality and detail has been given during installation surely will require added time and money. However, the most significant consequences that will affect the building owner could be delays in obtaining an occupancy permit or worse yet, a system that fails to perform as designed. The use of a quality field inspection by a qualified third party during the course of construction will help prevent unwanted and unpleasant surprises when the fire marshal walks through the door on test day.

Vibration Isolator and Sound Suppressor Installation Concerns

How to avoid equipment sound and occupant fury

By **Robert W. Tinsley, PE, CFPS**
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You have now designed what appears to be a nice, quiet system. All of a sudden, your pristine design is put into the hands of Philistines—the mechanical contractor hired to install it! With weather constraints, liquidated damages, labor shortages, and a number of other factors, simply getting the system installed takes precedence over installing it the way it was drawn. Inspection is the last chance you have to get it right before you start getting calls from an irate owner.

VIBRATION ISOLATORS

All major pieces of rotating equipment have vibration isolators on them, right? Not necessarily. There are several things you have to look at to make sure the isolator will operate properly.

First, make sure the isolators are not still in shipping position, particularly in air handlers with independently isolated fans. Such equipment is shipped with the internal isolators cranked down with shipping bolts as tight as they can go to make the whole assembly rigid, which is good for shipping but bad for operation. Open the fan access door and make sure the shipping bolts have been removed and the fan assembly moves freely and without banging against the isolators. Check any base-mounted equipment on isolators for free movement.

Check the static deflection on the isolators. One of the most common sources of equipment noise is overloaded isolators. If the isolator is overloaded the equipment can bottom out while operating, transmitting vibrations directly into the building structure. To find the actual static deflection, measure the height of the loaded isolator and subtract that figure from the unloaded height in the catalog or submittal. Be sure to use the dimension for the spring height and not the overall height of the isolator.[1]

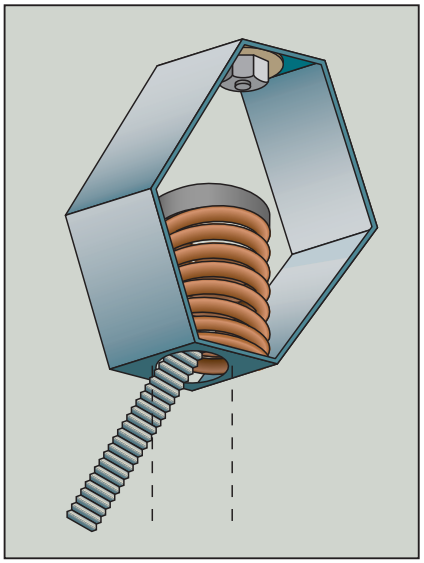

FIGURE 1. Hanger rod should not contact the hole in the bottom of the isolator box.

Sometimes you find spring isolators installed at the bottom of the hanger rod. Because of the flexibility of the hanger rod, some vibration can be transmitted to the structure even with a properly sized isolator. To avoid this problem, mount the isolators at the top of the rod and fasten them to the stiffest part of the structure.[2]

Another common problem with hanger isolators is misalignment. Sometimes, because of structural peculiarities, the isolators can't be mounted directly over the hanger rod attachment points to the equipment below. If the hanger rod contacts the hole in the bottom of the isolator box, any vibrations from the equipment will short-circuit the isolator (Figure 1). You might as well not have one there. Which brings up another class of problem.

SHORT CIRCUITS

In this case, a short circuit occurs when vibration bypasses the isolator. The most common form of this, other than that mentioned above, occurs with base-mounted equipment. Let's say you have a chiller or pump sitting on an isolated base. Sometime during construction, one of the workmen dropped a bolt and kicked it under the equipment base. Maybe he didn't see where it went or simply couldn't reach it to remove it. So it sits there until the equipment is started. Now there isn't sufficient clearance to allow the equipment to move freely, so a properly isolated piece of equipment gets really noisy and no one can figure out why.

Another common short-circuit path is electrical conduit or condensate piping that no one thought to isolate because, "Hey, it's just a ¾-in. pipe; why bother?" How many times have you seen the wiring for a fan-coil or water-source heat pump hard-piped into the disconnect bolted to the side of the unit? Any connection—duct, pipe or conduit—to a piece of equipment that has a rotating element has to be made with a flexible connection. Don't use braided-metal or metal bellows connectors for this service. Their proper use is for expansion compensation, not vibration isolation.[3]

DUCTWORK AND DIFFUSERS

No matter how careful you are during design to route ductwork around obstructions, out in the field, there will always be something you didn't see or that wasn't represented on the drawings. So the ductwork has to take a little jog to the side, a small rise or a drop. Most of the time this isn't a problem. Sometimes, however, if the transitions are too abrupt you need to intervene. Just try to be sure that the transitions follow SMACNA guidelines. If there isn't sufficient room for that to be possible, you may have to stiffen up the ductwork or increase the metal gauge in that area to compensate. Medium and high velocity ductwork is particularly sensitive to abrupt transitions.[2]

When you have any penetrations through sound-rated partitions or slabs, make sure they are sleeved and caulked

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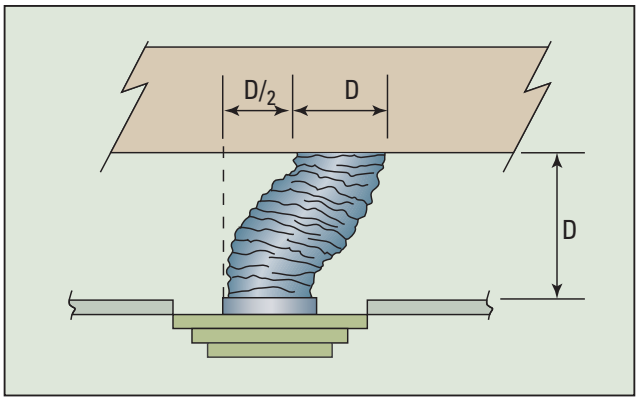

FIGURE 2. Illustration of an offset that can increase noise.

with a flexible, non-hardening sealant.

Always check to make sure that duct liner and turning vanes have been installed where you called for them. Don't let out of sight be out of mind.

The placement of sound traps is extremely important. No part of the ductwork upstream from the sound trap should pass through a sound-rated partition. Don't be lulled into a false sense of security because "It's just a short piece of ductwork."

Make sure that none of the elements from the other trades are in contact with the ductwork. Support wires for dropped ceilings and lights are major offenders here. If those wires are in contact with the duct, slight vibrations in the ductwork will pass down the wire and rattle the ceiling, as well as go up into the structure. Also be careful of pipes and pipe trapezes that rest against the top of the duct. Those aren't always easy to see before the ceiling is installed. After it goes in and you're trying to trace a rattle, these contacts are hidden and very difficult to spot.

Pay attention to diffuser-inlet conditions. Everyone knows that tight turns are noisemakers. Try to make sure that you have three duct-diameters of straight duct dropping into the diffuser. What's not so well-known is that offsets also cause noise increases. An offset of half a duct diameter from a short, straight drop out of a trunk duct can add 12 to 15 dB to a diffuser manufacturer's rating[3] (Figure 2).

FANS, AIR HANDLERS, FAN-COIL UNITS, AND VAV BOXES

First, make sure there is a flexible connection between the unit discharge and the ductwork. Then make sure the flexible connector is not stretched tightly. Even though the connector is flexible, if it's stretched tightly, it can cause vibration in the ductwork. Next, make sure the duct collar on the discharge of the unit is far enough from the ductwork to allow free movement. I recently had a job where the duct collar on a make-up air unit was shoved into the distribution duct. The flexible connector (yes, they had actually installed one) was bunched up around the outside of the duct. It kept air leaks to a minimum, but didn't do much for vibration isolation.

For fan-coil units, make sure there are no hard connections to piping, ducts, or conduits.With large air-handling units, in addition to all that has been mentioned before, see that sound traps, duct branches and other transitions or obstructions are at least three equivalent duct diameters from the unit discharge.

VAV boxes live and die by inlet and outlet conditions. Verify that the downstream ductwork is lined for at least 10 ft and try to get a straight run of hard duct at least three duct diameters long into the unit.

LARGE EQUIPMENT

There is little to be said about large equipment such as chillers, boilers, and cooling towers that hasn't been said already. Just be sure that the cooling towers are oriented the way you designed them, with the noisy side pointed away from occupied areas.

CONCLUSION

As I mentioned in the previous article, ("Designing without noise." February 2001,), common sense will go a long way toward nipping noise problems in the bud. As you perform your construction observation (lawyers don't like us to use the word "inspection" any more) just keep in mind that rigid connections to equipment with rotating elements will cause noise problems, as will tight turns into or out of that equipment. Oh, by the way, make sure that the equipment that was installed is the same as the equipment that was submitted! May all your jobs be quiet.

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