Resolving Noises During Commissioning

Last chance to assure a neutral sound level

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C omfort. That’s basically what our business is about. We are supposed to make the people that inhabit the buildings we design comfortable. Given our training, we spend virtually all of our time and effort trying to assure thermal comfort and don’t often consider acoustic comfort in spite of the fact that noise, especially low-frequency noise associated with HVAC, can adversely affect productivity.1 In commissioning, we are aiming for a comfortable or “neutral” sound. This is generally considered a noise that is free from high levels of rumble (below 125 Hz), roar (125 Hz to 500 Hz), whoosh (500 Hz to 2,000 Hz), hiss (2,000 Hz to 8,000 Hz), fluctuation (detectable variations in sound pressure level), roughness (fluctuations in level between 20 Hz and 300 Hz), and throb.2 Commissioning is the very last chance we get to try to assure that neutral sound level before the building is occupied.

By definition, commissioning requires that achievable noise levels for the building be identified during design and included in the contract documents. Table 1 lists the ASHRAE-recommended room criteria (RC) levels for many of the room types found in modern buildings.

DOWN AND DIRTY

In this case, commissioning requires actual measurement of sound levels in the building while the equipment is operating. It’s also considered a good thing if there aren’t any workmen or occupants around muddying up the acoustical environment.

In my opinion, there are two levels of noise/vibration commissioning: Level 1 can be done by your average Joe HVAC Engineer and consists of not much more than evaluating the RC levels within the building; Level 2 requires the services of an acoustician or acoustical engineer to measure sound levels of specific pieces of equipment or vibration levels. Level 1 makes up the majority of what we design engineers get into. Level 2 comes into play with exterior sound levels, recording studios, performing arts centers, semiconductor-manufacturing facilities, and other buildings where even small, physically imperceptible amounts of vibration can affect activities within the building. Level 2 requires a specialist’s understanding of sound and vibration propagation and the instruments and methods of measurement. Even Level 1 commissioning shouldn’t be attempted without a more-than-casual familiarity with a good manual such as the NEBB’s Procedural Standards for the Measurement and Assessment of Sound and Vibration (available from the ASHRAE Bookstore).

INSTRUMENTATION AND METHODOLOGY

First off, don’t go to Radio Shack and buy the $39.99 sound meter in the display case. All that measures is the A-weighted and C-weighted averages of the sound level in a room, both of which are virtually useless in this situation. The A-weighted average doesn’t indicate the level of low-frequency sounds that make up the majority of sounds generated by HVAC systems. About the only thing it is useful for is measuring the comparative loudness of one area to another.3

The instrument you should be using is a battery-operated, hand-held Type 1 sound-level meter that conforms to ANSI Standard S1.4, American National Standard Specifications for Sound Level Meters. This type of meter has linear, A- and C-weighting networks, octave-band filters that give you the average level at the center frequencies from 31 Hz to 8,000 Hz, and a needle or LCD display to show sound level fluctuations. These meters are not cheap. If all you are going to use it for is the occasional troubleshooting or commissioning gig, you should probably rent the instrument when you need it. Make sure the kit has an acoustic calibrator in it. This calibrator should be used before each measurement session.

Having a tripod on which to mount the sound meter increases the amount of impedimenta that you have to carry, but it makes taking measurements easier. Most sound meters require that you measure each of the eight octave-band centers one at a time. For instance, first you would set the octave band filter to the 31.5 Hz band and take a reading. Then you would change the band filter to the 63 Hz band and take a reading, continuing on through the 4,000 Hz band. Doing this while trying to hold the meter in the same position throughout requires at least three hands and the stamina of an Olympic athlete. Save the medical bills and bring a tripod.

Sound Measurement Checklist

Before you leave the office, make sure that the sound meter has fresh batteries and is properly calibrated.

Use your common sense to choose the best place to take a measurement by walking through the space and noting changes in sound level or quality.

Make sure you have the sound meter’s foam windscreen installed.

Point the sound meter’s microphone approximately 45 deg from the loudest source of sound.

Set the sound meter’s fast/slow switch to slow. This dampens fluctuations in the sound level and makes measurements easier to read.

Don’t get too close to the sound meter. Hold it at arm’s length or mount it on a tripod.

Don’t place the sound meter too close to objects or walls. Try to stay at least three feet from walls and furniture. This will minimize the effect of sound reflection.

Record the results on an RC worksheet.

Compare the results to the levels specified in the contract documents.

In our industry there are two basic ways currently in wide use to rate a sound environment: NC (Noise Criteria) and RC (Room Criteria). NC is the older of the two and is less useful in commissioning for three fundamental reasons: a noise with the spectrum shape of an NC curve contains too much rumble and hiss; many problem
noises in HVAC occur in the 16 and 31.5 Hz octave bands which are not covered by the NC curves; and since the NC rating is based only on the tangency to a given rating curve, one could assign the same NC rating to two sounds with widely differing characteristics. NC ratings are still found useful for rating components such as air devices. For these reasons, we will pass lightly over the venerable NC and move quickly on to RC.

The RC curves were developed to allow acoustic environments to be rated more qualitatively than is possible with the NC curves. The octave bands cover the sound spectrum from 16 Hz to 4,000 Hz. The first step in constructing an RC curve is to measure the sound pressure levels in each of the octave bands and record them on a blank RC worksheet such as can be obtained from the National Environmental Balancing Bureau (NEBB) or the Associated Air Balance Council (AABC). Figure 1 shows an example.

### TABLE 1. Design guidelines for HVAC system noise in unoccupied spaces (Note 4)

<table>
<thead>
<tr>
<th>Space</th>
<th>RC (N)</th>
<th>Space</th>
<th>RC (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private residences, apartments</td>
<td>25-35</td>
<td>Laboratories (with fume hoods)</td>
<td>45-55</td>
</tr>
<tr>
<td>Condominiums</td>
<td></td>
<td>testing/research, minimal speech comm.</td>
<td></td>
</tr>
<tr>
<td>Hotels/Motels</td>
<td></td>
<td>Research, extensive telephone usage, speech communication</td>
<td>40-50</td>
</tr>
<tr>
<td>Individual rooms or suites</td>
<td>25-35</td>
<td>Group teaching</td>
<td>35-45</td>
</tr>
<tr>
<td>Meeting/banquet rooms</td>
<td>25-35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service/support areas</td>
<td>35-45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotels/Motels</td>
<td></td>
<td>Churches, Mosques, Synagogues</td>
<td>25-35</td>
</tr>
</tbody>
</table>
| Individual rooms or suites           | 25-35  | with Critical music programs         | (Note 2)
| Meeting/banquet rooms                | 25-35  |                                    |        |
| Service/support areas                 | 35-45  |                                    |        |
| Office Buildings                      |        | Schools                              |        |
| Executive & private offices           | 25-35  | Classrooms up to 750 sq ft           | 40 (max.) |
| Conference rooms                     | 25-35  | Classrooms over 750 sq ft            | 35 (max.) |
| Teleconference rooms                 | 25 (max.) | Lecture rooms for more than 50 (unamplified speech) | |
| Open plan offices                    | 30-40  |                                    |        |
| Circulation & public lobbies         | 40-45  |                                    |        |
| Hospitals & Clinics                  |        | Libraries                            | 30-40  |
| Private rooms                        | 25-35  |                                    |        |
| Wards                                | 30-40  |                                    |        |
| Operating rooms                      | 25-35  | Courtrooms                           | 25-35  |
| Corridors                            | 30-40  | Unamplified speech                   | 30-40  |
| Public areas                         | 30-40  | Amplified speech                     |        |
| Performing Arts Spaces               |        | Indoor Stadia and Gymnasia           | 40-50 (Note 3) |
| Drama theaters                       | 25 (max.) | School and college gymasia and natatoria |        |
| Concert & recital Halls              | (Note 2)|                                    |        |
| Music teaching studios               | 25 (max.) | Large seating capacity spaces        | 45-55 (Note 3) |
| Music practice rooms                 | 35 (max.) | (with amplified Speech)              |        |

**Note 1:** The above values and ranges are based on judgement and experience, not quantitative evaluations of human reactions. They represent general limits of acceptability for typical building occupancies. Higher or lower values may be appropriate and should be based on a careful analysis of economics, space usage, and user needs. They are not intended to serve by themselves as a basis for a contractual requirement.

**Note 2:** An experienced acoustical consultant should be retained for guidance on acoustically critical spaces (below RC 30) and for all performing arts spaces.

**Note 3:** Spectrum levels and sound quality are of lesser importance in these spaces than are overall sound levels.

**Note 4:** When the quality of the sound in the space is important, specify criteria in terms of RC (N). If the quality of the sound in the space is of secondary concern, the criteria may be specified in terms of NC criteria.
The next step is to calculate the average of the readings in the 500-, 1,000-, and 2,000-
Hz octave bands and round off to the nearest integer. In this case that number is 35.
This is the RC level for the room. This number may, as in this case, not be equal to the
sound pressure level of the 1,000 Hz band.

Next, draw a line with a −5 dB per octave slope that passes
through the calculated RC level in the 1,000-Hz band
extended from the 16-Hz band to the 4,000-Hz band. The
relationship of the individual measured values to this line
determines the subjective character of the background
noise. If none of the measured values lies more than 5 dB
above the line from 16 Hz to 500 Hz or more than 3 dB
above the line from 500 Hz to 4,000 Hz, the background
noise can be classified as “neutral” denoted with an “(N)”
suffix.

A background noise is considered to be “hissy” if any of
the measured sound-pressure levels exceed the RC line
above 500 Hz by more than 3 dB. An “(H)” would be placed after the RC rating
number.

Sometimes in fans or pumps you can hear a hum, buzz, whine, or whistle. This is
classified as a tone. This can be indicated by two adjacent octave bands with the
same dB reading or one octave band with a reading significantly higher than the other
bands. A “tone” rates a “(T)” designation.

Excessive sound pressure levels in the 16 to 63 Hz octave band can result in a rattle in
the ceilings or walls. This is known as sound-induced vibration. If any of the
readings in those octave bands falls into the shaded area of the chart, the RC rating gets
an “(RV)” suffix.

Figure 1 shows a set of readings that would result in a rating of RC 35 (R, T, RV). There is a rumble present because the
readings in the 31.5 and 63 Hz bands are more than 5 dB above the RV 35 line. The
fact that the readings in those two bands are equal indicates the presence of a pure
tone. And since the reading in the 31.5 Hz band lies in the shaded area of the chart there are likely to be light levels of noise-in-
duced vibration in the walls and ceiling. Because none of the readings are more than
3 dB above the RC 35 line in the octave bands above 500 Hz, there is no hiss pres-
ent.

A final caveat: Don’t bite off more than you can chew. Noise and vibration are
complex. In many cases specialized training is required to properly evaluate a prob-
lem. If you are not sure, seek expert help.

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Guide to Noise and Vibration Control for
Commissioning VAV Diffusers

Making sure the system not only works, but is true to its design

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If commissioning begins at the design phase, commissioning systems with VAV diffusers should include confirmation of proper VAV diffuser selection, system supply air, and temperature and system static pressure as described in the design article (February 2001).

In the construction phase, commissioning VAV diffusers should include confirmation that their location does not disturb air induction and entrainment, and that the designer’s intent for supply air temperature control and static pressure control is carried out. These were described in the installation article (March 2001).

This article is about commissioning during the startup, functional testing, or acceptance phase. It also applies to commissioning several years later. Startup of the system is necessary before the system can be air balanced and the VAV diffusers checked. During this time, facilities people are also trained. Operation and maintenance after acceptance was discussed in the prior article (April 2001).

SYSTEM STARTUP
Before checking the VAV diffusers, make sure the system is operating properly. The fan must be running continuously during occupied hours, and the system should be able to supply air at both a volume and a temperature to satisfy design capacity.

Controls for a constant supply-air temperature should be calibrated and the sequence of operation and schedule implemented and documented. The electric wiring and pneumatic tubing should be connected to the static pressure controller and operating. Finally, verify that the ducts are attached to each VAV diffuser.

When the above, along with balancing, is completed, the VAV diffuser should maintain room temperature within tolerance of the setpoint. This can be verified with periodic temperature or a time-temperature recorder.

SYSTEM AIR BALANCING
Balancing is the key to a comfortable and efficient VAV system, which when balanced for the lowest static pressure, can reduce operation and maintenance costs. Systems with VAV diffusers are no exception to the balancing rule. While VAV diffusers sometimes are thought of as self-balancing, it is necessary to adjust the system to get within the air volume, static pressure, and sound limitation of the diffuser. Once balanced, the diffusers regulate air flow according to the temperature of the space in which they are located. For this reason, all manufacturers of VAV diffusers recommend balancing. Balancing can be eliminated only when the building has a low-pressure extended-plenum duct design where static pressure is closely controlled and equalizes in the duct.

All VAV systems are opened for maximum air flow and balanced to achieve design air volume at each diffuser. Final adjustments are made with a balancing damper at the takeoff before the runout to each diffuser. Usually, systems are balanced for cooling air volumes, which are typically larger than heating air volumes. If the reverse is true, the system should be balanced for heating.

There are many ways to open a VAV diffuser to achieve the maximum air flow needed for balancing.

For VAV cooling only and VAV cooling/constant volume heating diffusers, you can heat the building until the diffuser’s

System-operator-training checklist

- Know how the VAV diffuser works. Use the manufacturer’s literature to learn how it works and what to expect.
- Know how to adjust the temperature setpoint of the VAV diffuser.
- Know why the system supplied an almost constant supply-air temperature, how this is controlled, and, where applicable, when and how to reset to another constant supply air temperature.
- Know why supply-air static-pressure control/pressure independence is necessary and how it is controlled, and steps to troubleshoot the system and the VAV diffusers.

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damper opens. This method cannot be used with a VAV-heating/VAV-cooling diffuser or where heat is not available.

Lower the temperature setpoint to a cool level so that the diffuser will stay open at ordinary temperatures. Unfortunately, the factor setpoint is lost with this method, and the balancer must reset it afterward.

Place a temporary stop behind the damper to hold it open (this may be more difficult with disc-style VAV diffusers).

Better models offer options such as pins that hold the unit open or a spring that can be disconnected, allowing for the damper to open.

Use a network signal to open models connected to the DDC network.

Most VAV diffusers have an appearance panel to cover the internal mechanism. Be sure to check if the manufacturer recommends balancing with the panel on or off, since it can affect pressure drop.

Once all diffusers are open, balance the system as you would any other VAV system (see balancing checklist).

**TRAINING**

Facilities people—anyone, including tenants, involved with the operation of the building—need training on their specific system and on how a VAV diffuser works. Without this knowledge, they cannot be expected to correctly operate and maintain the system.

While this instruction can begin during the design phase and continue through the construction phase, it should be completed in the acceptance phase (see the system operator training checklist). Facilities people will then know what to expect and what not to expect from their system and the VAV diffusers.

At this time, the facilities people should be given literature from the VAV-diffuser manufacturer describing how it works, along with the operation-and-maintenance instructions for the VAV diffuser. This may be the approved submittal package.

**CONCLUSION**

Commissioning systems with VAV diffusers should include, but not be limited to, air balancing the system. In addition, commissioning should include confirmation that the system designer’s intent was carried out, especially with supply air temperature control and static pressure control. Perhaps most important is explaining the system and training the facilities people.

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**Balancing Checklist for Systems with VAV Diffusers**

- Prepare test reports by listing design flow and static pressure for each diffuser.
- Check for diversity by adding the diffuser design air flows and comparing to supply fan air flow and branch duct air flow. If there is diversity, either increase fan speed and air flow for balancing purposes, balance each diffuser at the same percentage of its design air flow, or balance segments of the system separately.
- Check design setting for supply fan static pressure controller.
- Check the return air fan capacity, exhaust flow, and minimum outside air requirements.
- Make sure the ductwork has been leak tested, and the air system is complete and functional.
- Check fan rotation.
- Set outside air control damper for maximum air and return air control damper to minimum if the outside temperature is within an acceptable range of comfort (50 to 80 F). If these ambient conditions cannot be met, balancing should be performed with the system’s minimum outside setting and maximum return air setting.
- Open static pressure control stations and close bypass dampers.
- Open VAV diffusers.
- Start fans and adjust variable inlet vanes (VIVs), speed control, or other flow controls for 100 percent flow. Record amps, volts, and rpm.
- Check static pressure across filters and coils.
- Check total supply and return air flow in main duct with Pitot tube traverse.
- Measure static pressure at supply fan controller sensor to check set point.
- Check air flow from the branch dampers with Pitot traverse.
- Measure air flow from the VAV diffuser with a direct reading balancing hood, or multiply the average velocity (measured with a velometer) by the A, supplied by the diffuser manufacturer.
- Lower fan speed until design air flow is obtained at the last diffuser when the balancing damper is wide open.
- Adjust the balancing damper for each VAV diffuser to achieve design air flow.
- Check and record fan amps, volts, and rpm.
- Check total supply and return air flow in main duct again with Pitot tube traverse.
- Measure the static pressure at the sensor for the controllers. Set each controller at the static pressure measured at its sensor.
- Return diffuser to normal operating conditions (by reversing the method used to open them).
- Return static pressure control stations, bypass the outside air dampers, VIVs, and fan speed control to normal operating conditions.
- Check supply and return fans for proper tracking.
Commissioning Sprinkler and Standpipe Systems

A Primer on What Steps to Take and Codes to Follow

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Sprinkler and standpipe systems, and their associated water-supply components, like other building systems, require proper commissioning to verify proper system installation and performance.

UNDERGROUND FIRELINES

The installation of underground mains for fire protection service is governed by NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

Prior to backfilling, the excavation underground mains should be inspected for proper installation and restraint. Additionally, the piping is required to be flushed at specified minimum flow rates until all foreign matter is discharged and the water runs clear. Flow flush rate should not be less than 390 gpm for 4-in. pipe, 880 gpm for 6-in. pipe, 1,560 gpm for 8-in. pipe, 2,440 gpm for 10-in. pipe, and 3,520 gpm for 12-in. pipe.

A hydrostatic test of the pipe is also required. The hydrostatic test should be made at not less than 200 psi for a minimum of 2 hr, or 50 psi above maximum static pressure if anticipated static pressure is in excess of 150 psi. New pipe with rubber gasketed joints should have little or no leakage during the hydrostatic test. Minor leakage equally distributed over all joints is acceptable provided the amount of leakage does not exceed 2 quarts per hour per 100 joints. If the rate of leakage exceeds this threshold, or the leakage comes from only a few joints and not uniformly throughout the installation, the test has failed. If the test section is isolated by metal seeded valves, an additional 1 fluid ounce per in. of valve diameter per hour per valve may be added to the allowable leakage rate.

Upon completion of installation and testing, the contractor should provide a Contractor’s Material and Test Certificate for the underground piping.

FIRE PUMPS

Most fire pumps used in commercial buildings use either an electric motor or diesel engine driver. The commissioning testing varies slightly depending on the type of driver and its associated controller.

The installation of fire pumps is governed by NFPA 20, Standard for the Installation of Centrifugal Fire Pumps.

Prior to connecting suction piping to the pump, all suction piping must be flushed. NFPA 20 specifies different flush criteria than does NFPA 24. Per NFPA 20, 4-in. pipe should be flushed at 590 gpm, 6-in. pipe at 1,360 gpm, 8-in. pipe at 2,350 gpm, 10-in. pipe at 3,670 gpm, and 12-in. pipe at 5,290 gpm.

All system piping (suction and discharge) should be hydrostatically tested. The hydrostatic test should be conducted at 200 psi for 2 hr, or at 50 psi above the maximum anticipated pressure. No drop in pressure is allowed during the hydrostatic test.

After completing the flushing and hydrostatic testing of the installation, a field acceptance test should be conducted on the pump. Prior to conducting the field acceptance test, a copy of the manufacturer’s certified pump test characteristic curve should be made available for comparison to the field test results. The field test results should match the factory characteristic performance curve.

During the field acceptance test, the pump should be flushed at a minimum of 3 points along its characteristic curve. Those points are 65 percent of rated capacity, 100 percent of rated capacity, and 150 percent of rated capacity. The pump discharge should be regulated to achieve these required flow points. At each of the test points, the net pump pressure, rated water flow, volts, and amperes for electric motor-driven pumps and pump speed should be recorded.

On electric motors operating at the rated voltage and frequency the amp rating should not exceed the product of the full-load amp rating times the allowable service factor as stamped on the motor nameplate.

If the electric motors are operating under varying voltage, the product of the actual voltage and current demand should not exceed the product of the rated voltage and rated full-load current times the allowable service factor. The voltage at the motor should not vary more than 5-percent below or 10-percent above the rated voltage during the test.

For engine-driven pump units, the governor on the engine driver should be set at the time of the test to properly regulate the engine speed at the rated pump speed.

After completion of the flow test, a load start test should be conducted. The pump must be started and brought up to rated speed without interruption with maximum flow through the pump.

During the acceptance testing of the pump, the pump should start in an automatic starting configuration no less than six times and from a manual start no less than six times. For an engine-driven pump, half of the starts should be performed utilizing each of the two battery sets. Each time the pump is started it should be allowed to operate for a minimum of 5 min before shutdown.

During the test procedure, the setpoints for automatic pump starting should be set on the system mercoid switch and verified by a calibrated test gauge. The setpoints on the fire pump must be coordinated with the start and stop setpoints of the jockey pump for the installation to prevent unnecessary cycling of the fire pump.

Fire pump controllers are required to be provided with an emergency handle for manual operation. During the acceptance test, this manual emergency handle operation should be done a minimum of once from each available power source. For electric pumps with an emergency power supply, a normal power failure should be simulated with the pump operating at peak load. Transfer from the normal source to the alternate source and retransfer from the alternate source to the normal source should not cause opening of the overcurrent protection devices in either line.

The fire pump transfer switch must be arranged to automatically start the emergency generator. The load of the pump must be assumed onto the generator within 30 sec of loss of normal power. Half of the required start and stops should be done from each of the two power sources.

If the pump installation includes pressure relief valves or other special water-control valves such as a suction-pressure control valve or a discharge-pressure regulating valve, these valves should be tested in accordance with the manufacturer’s instructions and properly set using calibrated gauges during the acceptance test procedure.

Where fire pumps provide the supply to a sprinkler or standpipe system, the pump should be arranged for manual shut down only. This is usually a jumper setting inside the pump controller. Verification should be made that the pump is configured for manual
shut down at the end of the acceptance test.

**STANDPIPE SYSTEMS**

The installation and acceptance testing of standpipe systems is governed by NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

All standpipe systems should be hydrostatically tested at 200 psi for 2 hr or 50 psi over the maximum static pressure anticipated in the system for 2 hr. No leakage is permissible during this hydrostatic testing.

Several flow tests are required of new standpipe system installations.

The water supply should be tested to verify compliance with the design assumptions. The test should be conducted by flowing water from the hydraulically most remote hose connection in the system.

A flow test must be conducted at each roof outlet of the system to verify that required pressures and flows are available in the system. Generally the required pressure and flow is 500 gpm available at the top of the riser with a minimum residual pressure of 100 psi. During testing, it should not be anticipated to be able to flow 500 gpm from a single standpipe outlet. Two hose outlets will likely be necessary to achieve the 500-gpm flow.

In buildings with a maximum static pressure above 175 psi, pressure-regulating devices are required at the hose valves. Each pressure-regulating device must be tested to verify that the installation is correct, the device is properly operating, and that the inlet and outlet pressures to the device are in accordance with the design.

On systems using pressure-regulating devices at the hose valves, the standard requires the installation of a 3-in. drain riser to allow sufficient flow at the hose valve to properly calibrate and test the pressure regulating devices. While testing the pressure-regulating devices, static and residual inlet pressure and static and residual outlet pressure and flow should be recorded. This information must be recorded on the contractor’s test certificate.

Dry standpipe systems with an automatic water supply should be tested to verify that 250 gpm can be delivered to the most remote hose valve within 3 min of opening the hose valve. If water cannot be delivered within three min, the standpipe can be arranged to be precharged with water as long as sub-freezing conditions will not be a concern at the location of the standpipe.

**SPRINKLER SYSTEMS**

The installation of automatic sprinkler systems is governed by NFPA 13, *Standard for the Installation of Sprinklers*. All sprinkler installation should be hydrostatically tested at 200 psi for a minimum of 2 hr. If the anticipated system static pressure exceeds 150 psi, the hydrostatic test should be performed at 50 psi above the maximum anticipated pressure.

Sprinkler-system water-flow alarms, whether mechanical or electrical, should be tested by operating the inspector’s test connection on the system. It should be verified that the inspector’s test connection is provided with an orifice equal in size to the smallest sprinkler system orifice installed in the system. An audible alarm must be received at the premises within 5 min after flow is initiated and it should continue until flow has stopped. In installations where electric water flow indicating devices are tied to a fire alarm system in accordance with the requirements of NFPA 72, *National Fire Alarm Code*, the maximum duration for the initiation of water flow to receipt of the alarm signal is 90 sec.

On dry pipe systems a test should be performed by opening the inspector’s test connection to verify that water reaches the test connection within 60 sec of opening the test connection valve. Initial system air pressure and the air pressure when the dry pipe valve releases

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should be recorded.

During system acceptance testing, proper air pressure should be verified. Insufficient air pressure will lead to nuisance tripping of the dry pipe valve. Air pressure that is too high will result in an extended system discharge time.

All sprinkler-system pressure-regulating valves must be tested to verify that the devices properly regulate outlet pressures at both maximum and normal inlet pressure conditions. Each pressure regulating valve should be flow-tested. The results of the flow test should include static and residual inlet pressures, static and residual outlet pressures, and flow rate. This information should be recorded on the contractor’s test certificate.

FIRE ALARM CONNECTIONS

In buildings with fire alarm systems installed in accordance with NFPA 72, sprinkler, standpipe, pump, and underground mains will have required connections to the fire alarm system. All valves controlling water supplies to any sprinkler or standpipe system must be electrically monitored to indicate tampering. An indication should be received at the system control panel when the valve is turned more than 1.5 revolutions from its normal fully open position.

The alarm system must have the ability to differentiate between an opening in the circuit wiring and a valve out of position.

Flow switches to indicate water flow in the piping network are often provided in standpipe risers. Additionally, they are provided in each sprinkler system. Tests for the proper operation of the water flow switch must be conducted by actually flowing water in the system. The alarm signal should be received at the fire alarm control panel within 90 sec of the initiation of water flow. The flow must be through an orifice equal in size to the smallest orifice within the sprinkler system.

On a dry pipe system, the fire alarm system should monitor both high and low air pressure in the piping network. Switches are available that have two set points in one device to provide this function. Insufficient air pressure could lead to inadvertent operation of the dry pipe valve. If the pressure is too high it may delay delivery of water when a sprinkler is activated.

Electric fire pumps require three connections to the fire-alarm system: one for pump running, phase reversal, and loss of power. If an electric fire pump is provided with an automatic transfer switch and a secondary power supply, the alarm system also must monitor the secondary supply isolation switch position and the transfer switch position.

On diesel driven pumps the fire alarm system should be arranged to monitor the engine running condition, the controller main switch in the off or manual position, and trouble on the controller or engine.

CONCLUSION

Proper commissioning after the installation of new automatic sprinkler and standpipe systems is important to their proper operation. Ongoing testing and maintenance of these systems should also be conducted on a regular basis in accordance with the requirements contained in NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems.