

Fire Pump Supervision - Part 1

by Dean K. Wilson, P.E.

***Question:* As the Authority Having Jurisdiction in my suburban community, I have largely had to deal with relatively small commercial buildings. And, because our municipality has a very strong public water system, I have not had to deal with private fire pumps. Recently, one of the “big box” stores has broken ground for a gigantic distribution center. The architect has delivered the plans for me to review. I notice that this facility will have three fire pumps. Two diesel engine-driven 2,000 gpm pumps take suction from individual 300,000 gallon tanks located on the northeast and southwest corners of the property. The tanks have automatic fill from the public water supply. The third fire pump, an electric motor-driven unit rated at 1,500 gpm, takes suction from a 16-inch connection to a 24-inch public water main. Apparently, the fire alarm system will supervise the fire pumps. I don’t even know where to begin reviewing the fire alarm portion of this installation. Can you help me?**

I will certainly try to help you.

First of all, from your description it sounds as if you have one booster fire pump and two fire pumps. The difference in the designation comes from the suction source. Booster fire pumps take suction from the public water supply and boost the pressure to a level appropriate for the hazard.

Listed horizontal centrifugal booster fire pumps normally have a rating that specifies 120% of rated pressure at “shut-off” or when no water flow, 100% of rated pressure at 100% of rated flow, and 65% rated pressure at 150% of rated flow. Such pumps have a design that self-unloads. In other words, the maximum brake horsepower necessary to drive the pump occurs at around 110% to 120% of rated flow. Beyond that point on the pump discharge curve, the brake horsepower drops off or self-unloads.

The designer of the fire protection system will choose the pressure rating of the booster fire pump based on the residual pressure of the public water supply at the maximum specific rate of flow, measured in gallons per minute (gpm). In the case of this 1,500 gpm booster fire pump, the public water supply must produce 2,250 gpm at no less than 20 psi residual pressure. You will need to see evidence of a flow test of the public water supply in the immediate area of the facility to determine what the actual residual pressure remains at the 2,250 gpm flow. The booster fire pump will then add to that residual pressure the rated pump pressure to create a specific flow rate at a significantly increase in pressure. Thus, the reliability and capacity of the fire protection system depends completely on the reliability and capacity of the public water supply.

Listed horizontal centrifugal fire pumps have a similar rating as the booster fire pumps: 120% of rated pressure at “shut-off” or when no water flow, 100% of rated pressure at 100% of rated flow, and 65% rated pressure at 150% of rated flow. In contrast to booster fire pumps, fire pumps take suction from some static source of water, such as the two independent 300,000 gallon storage tanks you describe. Typically, fire pumps have a much lower suction pressure than booster fire pumps. In the case in point, the height of the tank above the center line of the fire pump will determine the suction pressure created by the column of water within the tank. For every foot of

elevation, the column of water will create 0.434 pounds per square inch (psi) of pressure. A forty-foot tall suction tank will create a suction pressure at the centerline of the pump of 17 psi.

The size and location of these particular fire pumps hint that the redundant pair may result from a recommendation from the insurance company issuing the property insurance policy for this facility. The high automatic sprinkler system water demand for large warehouses often motivates the insurance company to require redundant and independent water supplies. The third booster fire pump will likely provide the first-operating-pump to handle the demand for a relatively small fire at the facility. Once sufficient pressure drop occurs, the two fire pumps will start to supply additional flow and pressure.

While NFPA 72-2010, *National Fire Alarm and Signaling Code*[®], has specific requirements for using a fire alarm system to oversee the operational reliability of fire pumps and their associated water tanks, you should first look at the requirements in NFPA 20-2010, *Standard for the Installation of Stationary Pumps for Fire Protection*. In order to deal with this subject in an orderly fashion, in this first article I will guide you in looking at the requirements for electric motor-driven fire pumps.

NFPA 20-2010, Chapter 10, covers the requirements for Electric Drive Controllers and Accessories. Specific requirements relating to the type of supervision that a fire alarm system might provide include the following:

10.4.7* Fire Pump Alarm and Signal Devices Remote from Controller.

A.10.4.7 Where unusual conditions exist whereby pump operation is not certain, a "failed-to-operate" fire pump alarm is recommended. In order to supervise the power source for the fire pump alarm circuit, the controller can be arranged to start upon failure of the supervised alarm circuit power.

10.4.7.1 Where the pump room is not constantly attended, audible or visible signals powered by a source not exceeding 125 V shall be provided at a point of constant attendance.

10.4.7.2 These fire pump alarms and signals shall indicate the information in 10.4.7.2.1 through 10.4.7.2.4.

10.4.7.2.1 Pump or Motor Running. The signal shall actuate whenever the controller has operated into a motor-running condition. This signal circuit shall be energized by a separate reliable supervised power source or from the pump motor power, reduced to not more than 125 V.

10.4.7.2.2 Loss of Phase.

10.4.7.2.2.1 The fire pump alarm shall actuate whenever any phase at the line terminals of the motor contactor is lost.

10.4.7.2.2.2 All phases shall be monitored. Such monitoring shall detect loss of phase whether the motor is running or at rest.

10.4.7.2.2.3 When power is supplied from multiple power sources, monitoring of each power source for phase loss shall be permitted at any point electrically upstream of the line terminals of the contactor, provided all sources are monitored.

10.4.7.2.3 Phase Reversal. (See 10.4.6.2.) This fire pump alarm circuit shall be energized by a separate reliable supervised power source or from the pump motor power, reduced to not more than 125 V. The fire pump alarm shall actuate whenever the three-phase power at the line terminals of the motor contactor is reversed.

10.4.7.2.4 Controller Connected to Alternate Source. Where two sources of power are supplied to meet the requirements of 9.3.2, this signal shall indicate whenever the alternate source is the source supplying power to the controller. This signal circuit shall be energized by a separate, reliable, supervised power source, reduced to not more than 125 V.

10.4.8 Controller Contacts for Remote Indication. Controllers shall be equipped with contacts (open or closed) to operate circuits for the conditions in 10.4.7.2.1 through 10.4.7.2.3 and when a controller is equipped with a transfer switch in accordance with 10.4.7.2.4.

You will note in reading the above paragraphs that these requirements do not specifically require the connection of the remote signal devices to a fire alarm system. However, the use of a properly designed and installed fire alarm system offers the most reliable means of supervising the operational readiness of the fire pump.

Fortunately, as noted in 10.4.8, listed fire pump controllers come equipped with contacts that permit supervisory initiating device circuits from a fire alarm system to connect and monitor the stated features. An installation contractor must take note of the specific conditions that this Standard requires remote indication: Pump or Motor Running (10.4.7.2.1), Loss of Phase (10.4.7.2.2), Phase Reversal (10.4.7.2.3), and, when an alternate source of power is provided, Controller Connected to Alternate Source of Power (10.4.7.2.4).

Each supervised feature from the electric fire pump controller should produce a distinctive supervisory off-normal and supervisory restoration-to-normal signal at the fire alarm system control unit. If the location of the fire alarm system control unit does not have constant attendance, the fire alarm system should transmit distinctive signals to an appropriate supervising station.

In the particular case of this installation, the electric motor-driven booster fire pump represents one part of a more complex pumping system. Since the other pumps use diesel engines to drive the pumps, an alternate source of power would not normally be required in accordance with NFPA 20-2010, as follows:

9.3.3 An alternate source of power is not required where a backup engine-driven or backup steam turbine-driven fire pump is installed in accordance with this standard.

Naturally, in addition to the items stated above, the fire alarm system needs to monitor the operational status of all control valves associated with the booster fire pump installation. In addition, if the geographic location subjects the facility to freezing temperatures during certain seasons of the year, the fire alarm system should monitor the low temperature in the fire pump room.

In the next article, I will guide you in looking at the requirements for monitoring the operational readiness of the two diesel engine-driven fire pumps and their associated water tanks.

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