The Electrical Impact of IBC Fire Pump Criteria

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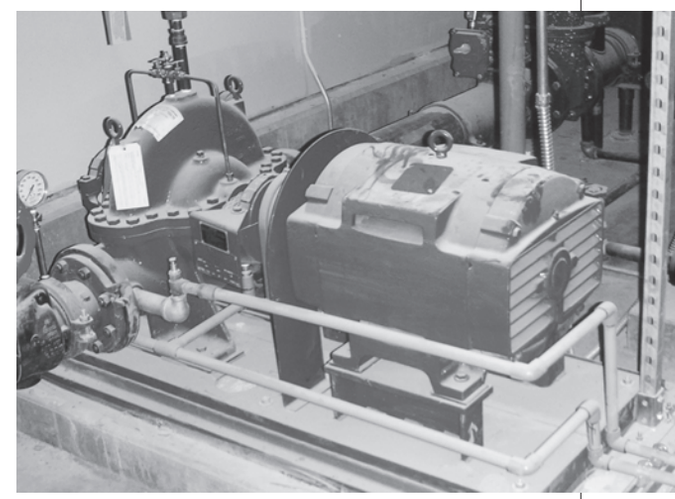
With the recent implementation of the International Building Code in the state of Washington, a need to increase fire pump horsepower has arisen. But equally important is the need to increase the size of associated generator and standy power equipment.

In recent design meetings with fire-protection engineers, it has been brought to our attention that the pump size calculations under the Uniform Building Code are no longer valid under the IBC. Specifically, new code parameters do not allow engineers to rely upon the same amount of city water pressure that was allowed under the UBC for sprinkler system pressure. As a result, larger horsepower fire pumps have been required. The new code, however, means associated generator and generator distribution size must equally increase.

The design and installation of the electrical infrastructure serving fire pump equipment is complex and dictated by multiple codes. There are many critical engineering criteria involved in the proper design and installation of these systems, but it is the responsibility of the electrical design engineer to coordinate with the authority having jurisdiction for final interpretation of all applicable codes. So, electrical engineers need to know about pump size specification.

Fire pumps must be sized based on lowest possible pressure from the public water supply, but able to handle higher pressures during low water usage.

Fire pumps, of course, are a critical part of a building's life-safety system. The fire pump maintains pressure in the sprinkler system and must remain operational at all times. Fire pumps must be sized based on lowest possible pressure from the public water supply, but must be able to handle higher pressures during low water usage. Fire pump designers have dealt with this issue in the past by providing pressure relief valves. In 2003, the National Fire Protection Assn. allowed the alternative of a break tank to eliminate the fluctuation in the public water pressure. In 2003, NFPA also allowed the use of variable-speed drives to deal with variable public water pressure. In 2004, the first VSDs listed for service became available. The electrical engineer must take the potential use of VSDs into consideration when sizing the standby generator. A VSD can reduce the motor's inrush. But, it can also add harmonic distortion to the system, causing alternator heating on the generator. So, the alternator must be specified with the VSD in mind.


Fire pump horsepower sizes have been increasing in Washington state since the IBC was implemented.

A matter of seconds

The fire pump is defined as a life-safety system under article 700.1 of the *National Electrical Code* (NEC). The fine print note in 700.1 indicates, "Emergency systems may also provide power to such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevator, fire pump, public safety communication systems…" As such, these systems need to be fed from a standby generator and must be operational within 10 seconds in the event of a power outage. A fire pump is typically a very substantial load. I have been involved in projects with fire pumps as large as 200 hp. Additionally, the largest step voltage drop allowed for a standby generator

serving a fire pump is 15%. The sheer size of the fire pump, the fact that it must be started within 10 seconds of an outage and the limitations in the percentage of voltage drop contribute considerably to the final size of a standby generator. In fact, the voltage drop limitation alone may force the design to incorporate a diesel-driven pump. (Diesel engine drive design requirements are covered in Chapter 11 of NFPA 20: *Standard for the Installation of Stationary Fire Pumps for Fire Protection*.)

With regard to fire protection, there are measures that can be taken to most efficiently utilize the emergency standby power system. For instance, specific loads can be removed during the operation of the fire pump to reduce the overall size of the generator and associated electrical distribution. Close coordination with the mechanical engineer must take place to identify any HVAC loads that will be locked out under the operation of a fire pump. These loads can be considered non-simultaneous and only the largest load must be considered when sizing the generator. Additionally, optional loads can be fed from an automatic transfer switch. This optional ATS can have a control feed from the fire pump and be transitioned to the off position when a fire pump starts under generator power (NEC 695.3(B) 1). Optional loads will not need to operate when the power fails and the sprinkler system calls for additional pressure.

NEC 700.12 (B) 1 indicates that for life-safety systems, an on-site fuel supply shall be provided with an on-premises fuel supply sufficient for not less than two hours' full demand operation of the system. NFPA 20, Section 9.6.2.2 indicates that "the fuel supply capacity shall be sufficient to provide eight hours of fire pump operation at 100% of rated pump capacity in addition to the supply required for other demands." It has been my experience that the local authorities have followed NEC and only required two hours of operation.

Additionally, NEC 695.3(B)(3) indicates, "the power sources shall be arranged so that a fire at one source will not cause an interruption at the other source." The generator should be located away from the main electrical service and protected from a fire in the main service room. Ideally, the generator should be located where it is protected from fire, either outdoors or in a room with fire-rated construction. The fire

pump controller should also be separated from both the main service and the generator to protect it from fire at one of the power sources. Furthermore, the fire pump controller is required to be service-entrance rated.

The overcurrent protection for the emergency source (generator) is sized similarly to a typical motor. NEC 430-152 allows a thermal magnetic breaker to be sized at a maximum of 250%. It would make little sense to have an overloaded fire pump pull down the entire emergency generator. All emergency loads would be lost including the fire pumps, communications systems, egress lighting and other critical loads as defined by NEC 700.1.

NEC 230-82 allows for the fire pump to be connected ahead of the main. Typically, the "normal" feed to the fire pump is fed directly out of the utility vault or tapped ahead of the main in the service gear. If tapped out of the service gear, the manufacturer must prepare the tap in a separate compartment and shall comply with NEC 230.82(4). In some jurisdictions in the Seattle area, the AHJ prefers the tap for the normal power to have no overcurrent protection. The thought behind not allowing overcurrent protection on the normal side is that the AHJ would prefer the fire pump to operate in a fire even if it is eventually damaged from an overload or a short circuit. Other jurisdictions in our area have required overcurrent protection on the normal side for short circuit protection only, and no overload protection, per NEC 695.4(B)(1). NFPA 20 provides a table for the lock rotor amps of various horsepower ratings. If the AHJ requires an overcurrent protection on the normal side of the fire pump, it must be located remotely from the main service. Most jurisdictions will also require a label indicating "Fire Pump Disconnect—Do Not Open." The purpose of the labeling is to reduce the possibility of accidental disconnect of the fire pump circuit from fire department personnel.

Where there are multiple fire pumps, the feeders to the fire pumps are based on 125% of the entire load, not just 125% of the largest motor. Oversizing the fire pump feeders will also help to reduce the total voltage drop at the fire pumps. NEC 695.7 indicates that "the voltage at the motor terminals shall not drop more than 5% below the voltage rating of the motor when the motor is operating at 115% of the full load current rating of the motor."

A jockey pump is used to maintain pressure in the sprinkler system under normal operating conditions. The jockey pump is typically much smaller than the fire pumps and is utilized for normal pressurization to the system. The jockey pump is not typically required to be on the generator and is not supplied with an internal ATS. NEC 695 requires the fire pump controller to be separate from the main service. NEC 695.6 (B) also has restrictions on the methods of routing electrical conductors from the service vault or the main service and to the fire pump controller. The fire pump feeders must be routed in one of the following methods:

- Feeders routed outside the building.
- Feeders encased in 2 in. of concrete.
- Feeders enclosed in construction dedicated to the fire pump circuit and with a minimum fire resistive rating of one hour.
- Be a listed electrical circuit protective system with a minimum fire rating of one hour.

A fire pump controller should be separated from the main service and the generator to protect it from a potential fire at those points.

Code officials have allowed mineral insulated (MI) cable and fire-rated RHH conductors in EMT to comply with the fourth listing above in lieu of routing the feeders outside the building or within 2 in. of concrete.

Per NEC 695.6 (E), within the pump room itself—from the controller to the pump—the feeders must be in rigid metallic conduit, intermediate metal conduit, MI cable or liquid-tight flexible metal conduit. Fire pump controllers should be as close as possible to the pumps. NEC indicates that the motor disconnect must be within sight and within 50 ft. of the motor.

Proper fire pump design, which references NFPA 20, NEC 695, NEC 430 as well as other NEC sections, is a critical piece of a building's life safety system. While it can be very complex, engineers must keep in mind that the proper design of these systems can be the difference between life and death.

For further information on the affects of the new edition of NEC on fire-protection systems, go to our Fire, Life Safety and Security community at csemag.com and scroll down to the December 1, 2004 issue of our eNewsletter for the first installment in a series on the 2005 edition of NEC. |cse|