

Sizing recommendations for fire pump applications

> White paper

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The building code includes special requirements for generators and transfer switches supplying fire pumps. This article captures those unique requirements and translates them into associated equipment sizing implications.

Where a generator set supplies power to an electric fire pump there are special sizing considerations outlined in the National Fire Protection Association (NFPA) and National Electrical Code (NEC) requirements.

The generator feed to a fire pump is typically one of two circuit arrangements. One arrangement uses a transfer switch integral to a fire pump controller (not shown).

The second arrangement uses a listed fire pump transfer switch separate from a fire pump controller (refer to FIGURE 1). For fire pump service, both an automatic transfer switch and a bypass-isolation transfer switch are available from Cummins Power Generation. This sizing recommendation covers sizing the generator set for either arrangement and sizing the transfer switch for the second arrangement, where separate from the fire pump controller.

Sizing the generator set

Background: NEC 695-7 requires that voltage dip no more than 15% of rated controller voltage at the fire pump controller line terminals (includes cable drop) during normal starting of the fire pump motor. This may translate to oversizing the generator set by a factor of two or three times to provide required motor starting kVA compared to when a 30-35% starting voltage dip is permitted.

Where the fire pump is the only significant load on the generator set, the starting kVA required will be much greater than the required running kVA. Since there are practical limits to the alternator capacity in a generator set, a larger genset may be required, resulting in a light load running condition for the engine (less than the recommended minimum of 30% of rated kW). To alleviate this, consider adding additional loads with low starting requirements, such as lighting, or the application of supplemental load banks, especially during normal routine system testing.

All fire pump controllers, whether reduced-voltage or DOL (direct-on-line), full voltage, include an emergency manual mechanical means to start the fire pump under full voltage should the starting circuit or contactor coil

FIRE PUMP CONTROLLER

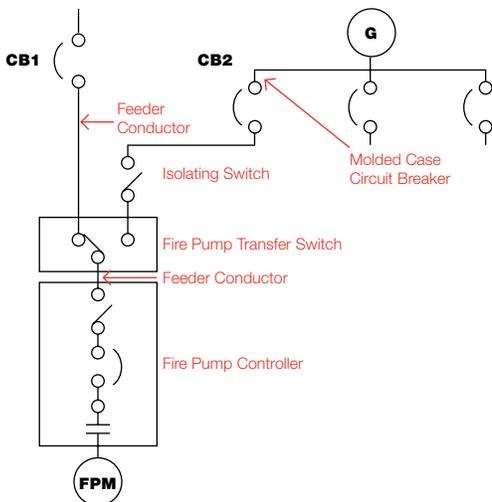


FIGURE 1 – Separate ATS feeding fire pump controller (NFPA 20 7-8.2.2 Arrangement II)

malfunction. The exception to NEC 695-7 states that the 15% voltage dip limit does not apply when using manual starting emergency means.

Caution: Cummins Power Generation recommends an analysis of generator set voltage and frequency dip performance when using the manual DOL starting. This analysis may indicate a larger generator is required to achieve desired performance during this condition. This may be desirable to get assurance that the fire pump controller does not drop out when automatic reduced voltage transition from start to run occurs prior to when the pump achieves near rated speed or when the pump cannot be accelerated during reduced voltage due to high operating head pressure.

Cummins GenSize™ sizing software allows a complete analysis of fire pump starting requirements. Using a special fire pump load icon in GenSize for the fire pump motor, establishes a maximum allowable Peak Voltage dip of 15% while starting the fire pump load (all fire pump loads will be included in the peak load calculations) after all other loads are already running on the generator.

Using GenSize, first size the generator with the starting means desired (DOL or reduced voltage) using the fire pump load icon. If the fire pump using DOL starting, is centrifugal (most are) and is not starting into a significant head pressure, then check Low Inertia in the fire pump motor load entry form. This will reduce the starting kW requirements for the genset. The generator will be sized to achieve the maximum 15% peak voltage dip. Then, delete the fire pump load(s) from the project. You will be asked if you want to reset the maximum peak voltage dip. Change this to the same value used for the maximum allowable step voltage dip. Then replace the fire pump load(s) with a regular motor load, DOL and check the cyclic box to obtain the peak load for both motors while allowing the peak voltage dip to exceed 15% for the emergency operating condition. Use the largest generator recommendation from these two calculations.

Note: It is not necessary to size the generator set for locked rotor current continuously.

Sizing the utility circuit breaker, CB1 (or fuses)

Size any over current device upstream of the fire pump controller on the utility line side to hold locked rotor current of the fire pump motor continuously, typically a minimum of 600% of motor FLA (Full Load Amps).

Because the maximum allowable current-limiting fuse for a given size transfer switch is higher than the maximum allowable molded case circuit breaker, using current-limiting fuses in lieu of a circuit breaker may allow a smaller transfer switch to be used.

Sizing the feeder conductors

Size the feeder conductors at a minimum of 125% of the motor full load current or next higher ampacity. Feeder conductors run from the circuit breaker at the generator (CB2) to the fire pump controller line terminals, and from the load side of CB1 to the fire pump controller line terminals.

The voltage drop requirement of NEC 695-7 also applies, so if the motor is large and the run is long, the feeder conductors may require oversizing. The facility designer is responsible for cable drop calculations.

Sizing the automatic transfer switch

1. Initially, size the ampere rating of the transfer switch to be equal to or next size greater than the required feeder conductors.
2. Verify that the over current device used on the utility line side, CB1, does not exceed the maximum allowable circuit breaker or fuse size allowed for the transfer switch. If it does, increase the transfer switch rating to one that includes CB1 as an allowable upstream breaker.

Sizing the generator circuit breaker, CB2

The objectives for sizing and selection of this over current device are:

- a) complying with code requirements,
- b) using a standard automatic molded case circuit breaker,
- c) selectively coordinating this breaker with locked rotor protection within the fire pump controller, and
- d) having sufficient available fault current from the generator to clear a faulted fire pump circuit without opening other branches of the generator supplied emergency system.

The circuit breaker should be a standard molded case circuit breaker; magnetic-only breakers and non-automatic molded case switches are not recommended.

About the author



Jim Iverson is a senior applications engineer for Cummins Power Generation, with an M.S. in Engineering Science, and a B.S. in Electrical Engineering. Since 1976, he has managed Transfer Switch Design, Systems Engineering, Switchgear &

Controls, and Technical Marketing & Sales. Jim provides technical direction to Commercial Marketing & Sales, contributes to domestic industry codes and standards development, offers sales and service training, offers technical input for published literature and software, publishes technical papers on industry topics, and provides application engineering support to customers.

A magnetic-only (instantaneous trip) circuit breaker is not recommended. These breakers are UL Component Recognized, but not UL Listed devices. They are only suitable for use in a UL listed assembly, and are typically included with overloads as part of a UL listed combination motor starter. They are not UL listed for feeder conductor protection.

A non-automatic molded case switch with integral high instantaneous self-protection is not recommended. If the fire pump circuit is faulted, the generator may have insufficient available fault current to trip the switch. If the fire pump branch is not interrupted during a fault, an upstream device may trip, leaving other emergency branches without power.

1. Size molded case breaker CB2 greater than 125% but less than 250% of the motor full load current.

NFPA 20, 6-6.5, requires this breaker to pickup the instantaneous load. NEC 695-6 (d) prohibits overload protection, but requires short circuit protection. With a minimum rating of 125%, by exclusion, the breaker is not providing overload protection according to NEC 430-32. With a maximum rating of 250%, for the breaker, by definition, qualifies as short-circuit protection as shown in Table 430-52 of NEC.

2. Within the range of 125% to 250%, select the smallest over current device that will allow pump motor locked rotor current to flow longer than the 20 seconds allowed by the fire pump controller integral protection.

For additional technical support, please contact your local Cummins Power Generation distributor. They can be found at www.cumminspower.com.

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