FIRE PUMP

Article 6.95 Philippine Electrical Code

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Topics to be discussed

- ❑ Governing codes
- ❑ Scope of Article 6.95 of PEC/ Not Covered
- ❑ What is a Fire Pump
- ❑ Most common type of fire pumps
- ❑ When is a fire pump required
- ❑ Automatic Fire Pump system and Operation
- ❑ Planning for fire pump location
- ❑ Power sources for electric motor-driven fire pumps
- ❑ Design Considerations and Computations
- ❑ Summary

GOVERNING CODES

▪ PEC	Philippine Electrical Code (Article 6.95)
▪ NFPA 70	National Electrical Code (NEC)
▪ NFPA 20	The Standard for the Installation of Stationary Pumps for Fire Protection
▪ IBC	International Building Code
▪ IFC	International Fire Code
▪ NFPA 5000	Building Construction and Safety Code
▪ NFPA 101	Life Safety Code
▪ NFPA 110	Standard for Emergency and Standby Power Systems

6.95.1.1 Scope under Philippine Electrical Code

Article 6.95 covers the installation of electric power sources and interconnecting circuits. It also covers switching and control equipment dedicated to fire pump drivers .

Article 6.95 doesn't cover:

(1) Performance, maintenance, testing, or internal wiring of the system components.

(2) Installation of pressure maintenance (jockey or makeup) pumps; Article 4.30 governs that, whether or not the fire pump supplies these pumps.

(3) Transfer equipment upstream of the fire pump transfer switch(es).

WHAT IS A FIRE PUMP?

FIRE PUMP

- **A fire pump is an equipme**
  provide the required water
  sustain a fire protection s
  emergency life safety syste

- **The fire protection package consists of:**
  - **adequately sized fire pump(s),**
  - **jockey pump(s),**
  - **Necessary controllers and drives**
  - **disconnecting means, transfer switch(es),**
  - **Properly sized wiring and other accessories.**

One of the principal PEC requirements for circuit protection is that you shutdown the equipment rather than let supply conductors melt from overload.

Article 6.95 requires just the opposite….

The core principle of Art. 6.95 is that the fire pump motor must run no matter what – because it exist solely to protect the facility and people who work there…..

MOST COMMON TYPES OF FIRE PUMPS

- ELECTRIC
- DIESEL

MOST COMMON TYPES OF FIRE PUMPS

- ELECTRIC

- **Electric driven fire pumps are more compact.**
- **Simple to design and maintain.**
- **Less of Environmental headache.**
- **No need for external fuel storage facilities. But,**
- **Entirely infrastructure dependent.**

❖ DIESEL

- **Requires combustible liquid fueling / refueling area.**
- **Requires a dedicated fuel storage for its operational sustainability (5.07 liter/Kw or 1 gal/HP plus 10% - NFPA 20). However,**
- **Diesel fire pump can operate anywhere as long as there is fuel.**

When is a Fire Pump Required?

When is a Fire Pump Required?

- The Fire Code of the Philippines requires all buildings higher than 15 meters (measured from the road) to be provided with sprinkler system.

- Multiple fire pumps are required as dictated by the largeness and height of the building.

AUTOMATIC FIRE PUMP SYSTEM AND OPERATION

Automatic Fire Pump System Uses Two Pumps:

- The main Fire Pump which delivers the large water volume to the sprinkler system during fire.

- The smaller (low flow/ high head) Jockey Pump that maintains the pressure of the system during normal condition (compensating for normal low water volume losses due to plumbing leaks).

- Operation - In case of fire however, and sprinkler head(s) opens, there will be a considerable pressure drop in the system over what the Jockey Pump can supply for, then the main Fire Pump starts to deliver the high water volume required to quench the fire.

PLANNING FOR FIRE PUMP LOCATION

Fire Pumps must be protected against:

- Explosion and Fire
- Rain and Sun
- Flooding and Earthquake
- Vandalism and other conditions.

Therefore, fire pump location should be selected properly.

Planning Considerations should include:

- Location for the Fire Pump in a room with at least:
  - 2 hrs. of fire rating or separation (for buildings not sprinklered and high rise)
  - 1 hr. (for sprinklered building but not including high rise)
  - 15.3 meters (50') away from the building when installed outdoors. (NFPA 20 Section 4.12, IBC Section 9.3)
  - For special requirement for High Rise, refer to NFPA 4.12.1.1.2 (10)
- Fire Pump rooms must be dedicated for the fire pump and its associated equipment only.

Power Sources Requirement for an Electric Motor Driven Fire Pump

Section 6.95.1.3 Electric motor-driven fire pumps shall have a reliable source of power

- ***Reliable power supply*** **As defined by NFPA 20 (Annex A) means:**
  - **The power supply has not had any shutdowns for longer than 4 hours in the previous year.**
  - **Has not experienced power outages that were not caused by natural disasters or grid failures.**
  - **The fire pump has not been supplied by overhead conductors.**
- ***An alternate power supply from a standby generator as an emergency power alternative source.***

Section 6.95.1.3 (a) Individual Sources

A single power supply source to the fire pump(s) under Section 6.95.1.3 of the PEC mandates that

- **this be from a reliable power source**
- **capable of carrying indefinitely the sum of the locked-rotor current (LRC) of the fire pump(s),the pressure maintenance (Jockey) pump motor(s) and the full load current of the associated fire pump accessory.**

Section 6.95.1.3 (a)(1) Electric Utility Service Connection

The fire pump(s) shall be permitted to be:

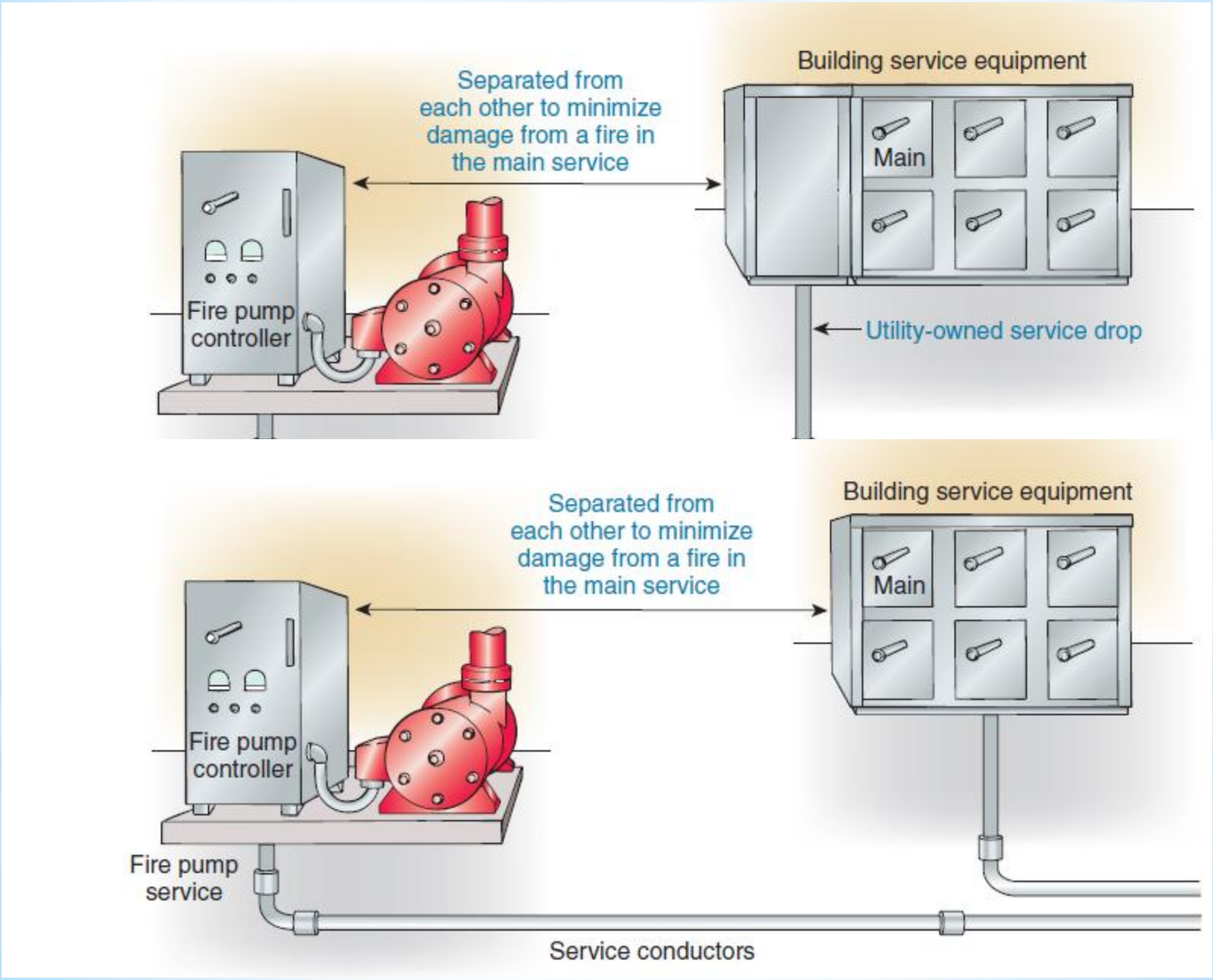
- **Supplied by a separate service, or a tap ahead of and not within the same cabinet, enclosure, or vertical switchboard section of the disconnecting means (see Figure A)**

Section 6.95.1.3 (a)(2)

- **"On-site Power Production Facility" that is continuously running (a standby generator does not meet this requirement)**

Section 6.95.1.3 (b) Multiple Sources

- **Multiple Sources or feeders from two or more sources.**


Building service equipment
Separated from each other to minimize damage from a fire in the main service
Main
Fire pump controller
Utility-owned service drop
Building service equipment
Separated from each other to minimize damage from a fire in the main service
Main
Fire pump controller
Fire pump service
Service conductors

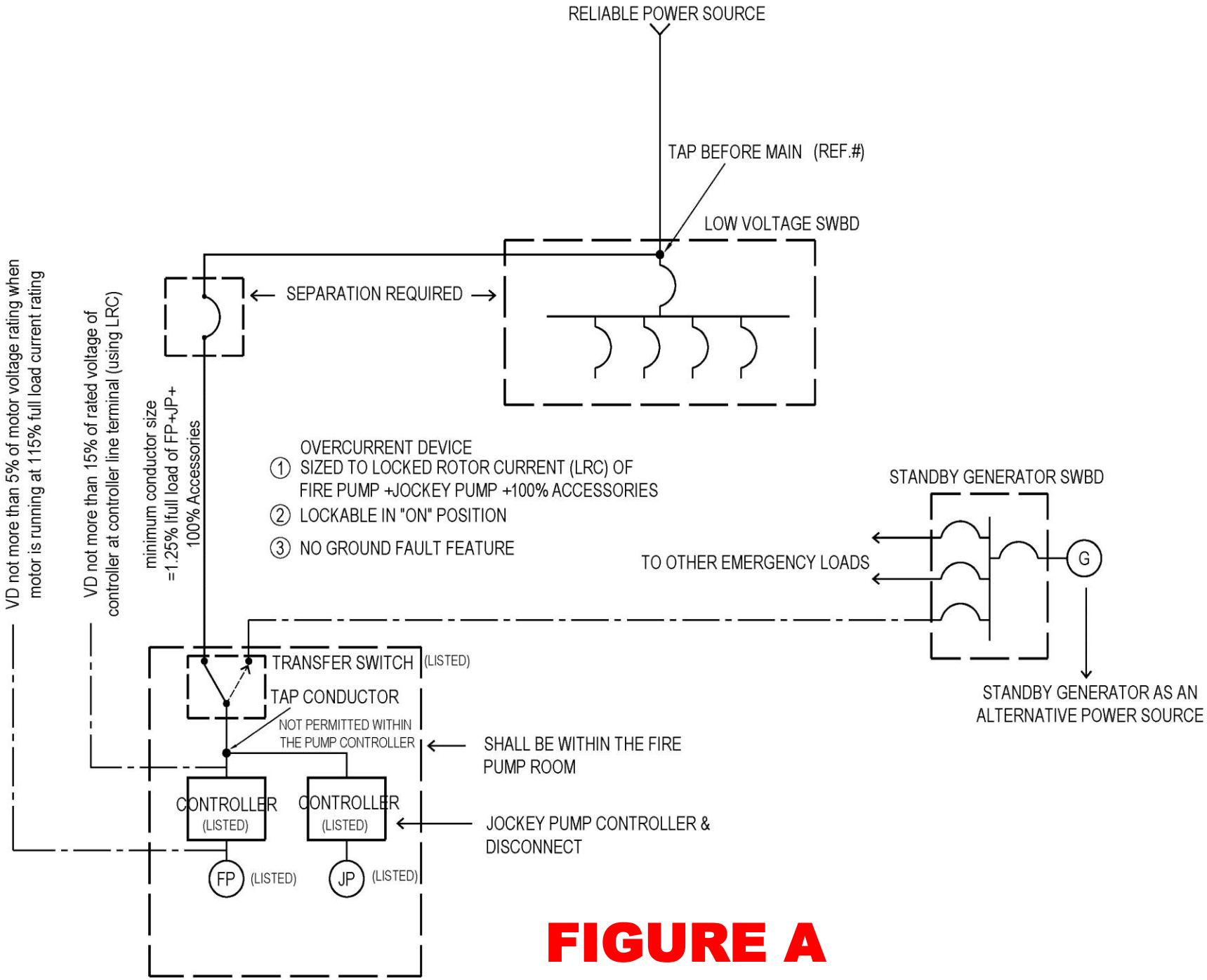

RELIABLE POWER SOURCE
TAP BEFORE MAIN (REF.#)
LOW VOLTAGE SWBD
SEPARATION REQUIRED
VD not more than 5% of motor voltage rating when motor is running at 115% full load current rating
VD not more than 15% of rated voltage of controller at controller line terminal (using LRC)
minimum conductor size =1.25% Ifull load of FP+JP+ 100% Accessories
OVERCURRENT DEVICE
1 SIZED TO LOCKED ROTOR CURRENT (LRC) OF FIRE PUMP +JOCKEY PUMP +100% ACCESSORIES
2 LOCKABLE IN "ON" POSITION
3 NO GROUND FAULT FEATURE
STANDBY GENERATOR SWBD
TO OTHER EMERGENCY LOADS
G
STANDBY GENERATOR AS AN ALTERNATIVE POWER SOURCE
TRANSFER SWITCH (LISTED)
TAP CONDUCTOR
NOT PERMITTED WITHIN THE PUMP CONTROLLER
SHALL BE WITHIN THE FIRE PUMP ROOM
CONTROLLER (LISTED)
CONTROLLER (LISTED)
JOCKEY PUMP CONTROLLER & DISCONNECT
FP (LISTED)
JP (LISTED)

FIGURE A

DESIGN CONSIDERATIONS

A. Power Conductors connected to the Fire Pump and Motor
B. Voltage Drop of conductors
C. Overcurrent Device Selection
D. Transformers
E. Pump controllers

A. Code Requirement in Sizing Conductors connected to the Fire Pump

- **125% of the full load current of the fire pump motor and jockey pump loads plus 100% of the auxiliary loads.**
- **Wire sizes shall be adjusted to maintain a voltage drop**
  - **Starting →Of not more than 15% (using the locked rotor value) from the source to the controller (line side)**
  - **Running →5% voltage drop using 115% of the full load current of the fire pump from the source to the motor terminal which ever conductor size is larger.**

A1. Steps in Sizing Conductors

1. **Determine the motor full load current from the motor nameplate or from the Table**
2. **Multiply the full load current by 1.25 per Table 4.30.14.4 Full load current PEC**
3. **Select supply conductor size per Table 3.10.1.16 PEC based upon the current calculated in step 2. Use 75C column as appropriate.**

3a. Conductors from controller to wye delta or Part winding motor (6 leads)

3a1. Part winding – Each conductor carries 50% of the motor full load curent

3a2. Wye delta – Each conductor carries 58 percent of the motor full load current.

3a3. Parallel conductors may be required for large motors

4. Verify that the conductor size will provide compliance with the voltage drop limitation

5. Consult motor manufacturers connection diagram for proper connection to controller.

B.VOLTAGE DROP

B.VOLTAGE DROP FORMULA

Cmil= (1.732 x K x I x D) / VD

Where:

- **Cmil – is the conductor size in circular mils**
- **K – is the conductor constant 12.9 ohms for copper**
- **I – is the current through the conductor**
- **D – is the distance of the pump from the source in feet to controller or motor terminal**
- **VD – is the allowable voltage drop**

Note:

1 circular mil is approximately equal to:

5.067×10^{-4} square millimetres

Section 6.951.14 (e) & (f) Wiring Methods

- **Conductor runs shall be protected, either run outside the building or in Rigid Steel conduit or intermediate conduit encased in 50mm (2”) concrete when run inside the building .**
- **All wiring from motor controllers to the pump motors shall be in:**
  - **rigid metal conduit or**
  - **intermediate metal conduit or**
  - **liquid tight flexible metal conduit or**
  - **liquid tight flexible non-metallic conduit type LFNC-B or**
  - **fire resistant cables (MI – mineral insulated) – can be used to add to the reliability of the fire pump wiring.**
- **1 hour fire rating is required for Fire pump wiring.**

C. Overcurrent protection for individual sources must comply with 6.95.1.4(a) or (b):

(1) Individual Sources. The OCPD(s) must be selected or set

- **to carry indefinitely the sum of the locked-rotor current of the largest fire pump motor and pressure maintenance pump motor(s), plus 100 percent of the full-load current of the other pump motors and fire pump accessory equipment.**

- **If the locked-rotor current value doesn't correspond to a standard OCPD size, use the next standard OCPD size per 2.40.1.6 of PEC. The requirement to carry the locked-rotor current indefinitely doesn't apply to fire pump motor conductors.**

(2) Assemblies. Overcurrent protection must be provided by an assembly listed for fire pump use. The OCPD must not open:

- **Within 2 minutes at 600 percent of the full-load current of the fire pump motor(s).**
- **With a re-start transient of 24 times the full-load current of the fire pump motor(s).**
- **Within 10 minutes at 300 percent of the full-load current of the fire pump motor(s).**

Also, the trip point for the circuit breaker must not be field adjustable.

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

The objectives for sizing and selection of this overcurrent device are:
1) Where a generator serves the fire pump, PE C 4.30.1.6 permits you to use the values in Table 4.30.14.4. Instead of setting the circuit breaker at locked rotor, Table 4.30.4.2 sizes the circuit breaker at a maximum of 250 percent of the largest motor, Then the FLC of all the other mootrs (jockey pumps) that are being fed by the generator must be added.

3) selectively coordinating this breaker with locked rotor protection within the fire pump controller, and

4) 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.

D. Transformers – Section 6.95.1.5

A) SIZE –Section 6.95.1.5(a)

If a transformer supplies an electric fire pump motor, size it at least 125 percent of the sum of the fire pump motor(s) and pressure maintenance pump(s) motor loads, plus 100 percent of the ampere rating of the fire pump's accessory equipment [695.5(A)].

B) OCPD Section 6.95.1.5(b)

Size the primary OCPD to carry indefinitely the sum of the locked-rotor current of the fire pump motor(s) and pressure maintenance pump motor(s), plus 100 percent of the ampere rating of the fire pump accessory equipment. Secondary overcurrent protection isn't permitted. The requirement to carry the locked-rotor currents indefinitely doesn't apply to fire pump motor conductors.

Pump Controller

SPECIAL CONSIDERATIONS FOR FIRE PUMP CONTROLLERS

a. **Service Disconnect** – Special rules pertaining to the service disconnects In order to minimize inadvertent disconnection

b. **Conductor Protection**

1. Special overcurrent and physical protection requirements for the power supply conductors exist to minimize potential interruption during a fire
2. Coordinated overcurrent protection of the motor branch circuit conductors to trip the circuit breaker in the fire pump controller rather than an upstream device

c. **No motor overload protection** – Fire pump motor protection is limited to locked rotor and short circuit protection only

d. **Critical components-** Certain conductors and electrical components are not protected from overcurrent in the interest of getting a distressed pump going

e. **No Ground Fault Protection** – Ground Fault protection is prohibited

f. **Control Circuits:**

1. External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open or short circuit) shall not prevent operation of pump(s) from all other internal or external means

- **Pump controller is required to be near the pump which it controls.**
  - **Prudence dictates that the controller should be installed at least 300mm (12”) above ground to avoid water damage.**
- **Pump controllers need to be listed.**
- **Pump controller normally starts the pump motor on reduced voltage but It is also equipped with a bypass switch that shunts the starter in case of emergencies. Hence, the motor is started on a Full Voltage Across the Line resulting in the locked rotor current.**

Listed fire pump controller and power transfer switch.

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- **The PEC requires the fire pump to run at up to a locked rotor current which is about 6 times the full load current.**
- **Protective device (from the normal power source) shall be rated to carry the locked rotor current.(preferably with an instantaneous trip and no ground fault protection).**
- **Protective device shall be locked in the closed position to avoid accidental power interruption to the pump. Disconnects to the fire pump shall be marked "Fire Pump Disconnecting Means". Letters shall be at least 25mm (1") in height and visible without opening the enclosure.**
- **If an alternate power supply is from a standby generator set, the code does not require it to be sized to carry the locked rotor current.**

- **Reduced starter tends to address and alleviate the burden of the locked rotor current on the generator set (since the generator set is only required to take on the Fire Pump running current).**
- **Listed transfer switch (color red for fire pump) is required to be located at the pump room for the transfer of power to the emergency generator supply. Again, the protective device at the generator supply is marked and can be locked in the closed position, to avoid nuisance power interruption.**

SUMMARY

1. Ensure continuity of power.

It is very important that the fire pump is powered continuously and inadvertent power disconnection is averted.

2. Lock the disconnecting means.

Make sure that the disconnecting means is not accidentally exercised, interrupting the power to the fire pump.

3. Allow the locked-rotor current.

- The overcurrent device should be set to allow locked rotor current to flow without tripping.
- The conductors are sized to no less than 125% of the full load current of the fire pump motor and 100% of the auxiliary loads that the circuit supplies.

4. Carry only the full load current.

The overcurrent protection device between the generator and the fire pump controller is not required to carry the locked rotor load of the fire pump motor.

5. Design feeding through a transformer.

- The primary overcurrent protection device has to be set to allow the locked rotor current of the fire pump and the full load of the associating loads.
- The secondary overcurrent protection is not allowed.

6. Account for voltage drop.

The voltage drop at the fire pump controller be 15% or less.

7. Protect conductors.

- The conductors supplying the fire pump need to be protected from physical damage.
- The conductors should be routed outside the building if feasible.
- If routed inside the building, the conductors have to be encased in 2 in.(50mm) of concrete.

The Fire Pump being an essential element in the Life Safety system must be maintained every now and then. As the saying goes,

"KEEP THE PUMP RUNNING NO MATTER WHAT"

END OF PRESENTATION