



Electric Service Standards		DATE 12-03-13
PREPARED BY Delivery Assurance – Design Support	SUBJECT IX. MOTORS, CONTROLLERS and AIR CONDITIONERS	SECTION: PAGE IX: 1 of 5

IX. MOTORS, CONTROLLERS AND AIR CONDITIONERS

A. General

Before ordering or installing any large polyphase or single phase motor, FPL should be consulted to determine the character and adequacy of the available service and the allowable starting current at the premises to be served. This information should be passed on to the suppliers of the proposed motorized equipment. This will assist suppliers in providing equipment and protective devices to obtain satisfactory operation at minimum cost, considering both initial installation and future maintenance.

Motors less than 7.5 horse power can be served with single phase service, unless three phase service is already being supplied. Motors 7.5 to 20 horsepower require open delta service (or wye if already being supplied), and motors larger than 20 horsepower require wye service. Availability of three phase service should be discussed in advance with FPL.

Single phase motors larger than one-half horsepower fed from 120/240 volt circuits should be connected for 240 volt operation. Smaller motors may be connected for 240 volts, where practicable, at the Customer's option.

The current required to start a motor is much greater than that required to operate it at full load after it has reached rated speed. If not controlled, this starting current may cause severe voltage fluctuations, not only on the wiring of the Customer using the motor, but also on other Customers' wiring. The more frequently the motor is started, the more objectionable these voltage fluctuations become.

The National Electrical Code, in Article 430, provides a table (430.7(B)) which classifies motors by their "locked-rotor" (starting) input requirements. A code letter is assigned to each requirement bracket. The brackets are given in "kilovolt-amperes" per horsepower which can be easily converted to amperes for a given motor. The starting current increases as the code letter increases. The appropriate letter is stamped on the motor nameplate.

Using this information, FPL has prepared **Table IX-1** for single phase motors, five horsepower and below. This table lists code letters and starting currents which will be acceptable at most locations on FPL's system. The value given is for one motor which does not start more than four times per hour. **Table IX-2** provides similar data for single phase air conditioners, but is based on the unit's rated output rather than horsepower.

B. FPL Approval of Starting Means for Large Motors

For motors larger than those listed in **Table IX-1**, or which start more frequently, the Customer may be required to provide reduced voltage or incremental starting equipment, to reduce each step of starting current to the value shown. FPL shall be consulted and will advise the Customer of its requirements.

In the case of three phase motors, because of the variety of service conditions and the large number of motor sizes available, FPL shall be contacted in each case to determine if reduced voltage or incremental starting will be required. If two or more motors are started simultaneously, the starting limitations apply to the total current of the group.

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IX: 2 of 5**Table IX-1**

**Single Phase Motors Acceptable for Across the Line
Starting at Most Locations on FPL System
Horsepower Ratings by NEC Letters
No more than Four Starts Per Hour**

ACCEPTABLE CODE LETTERS

HORSEPOWER	115 VOLTS(50 AMPS)	230 VOLTS	MAXIMUM STEP IN STARTING CURRENT
1/4	A THRU V	A THRU V	50 AMPS
1/3	A THRU S	A THRU V	50 AMPS
1/2	A THRU N	A THRU V	50 AMPS
3/4	A THRU J*	A THRU S	50 AMPS
1	A THRU G*	A THRU P	50 AMPS
1 1/2	A THRU C*	A THRU K	50 AMPS
2		A THRU H	60 AMPS
3		A THRU G	80 AMPS
5		A THRU F	120 AMPS

*These motors should be connected for 230 volt operation if feasible.

TABLE IX-2**Acceptable Air Conditioning Equipment, One Phase, 240 Volts**

SIZE IN TONS (NOTE 1)	SIZE IN BTU	*MAXIMUM ALLOWABLE STEP IN STARTING CURRENT AT 240V
1	12,000	40 AMPS
1 1/2	18,000	60 AMPS
2	24,000	80 AMPS
3	36,000	120 AMPS
4	48,000	160 AMPS
5 (NOTE 2)	60,000	200 AMPS

Note 1: Table based on units being sized and maintained so that there will be a maximum of four starts per hour.

Note 2: Better performance may sometimes be obtained by using two smaller units.

* This is the maximum allowed coincident starting current of any, or all of the system's components (compressor, condenser fan motor, and air handler blower motor). If the System Starting Current exceeds the values shown, the customer should investigate the installation of either a "hard start" kit or "stage" starting (or other method recommended by the manufacturer) to reduce the starting current to the level for which FPL's distribution system was designed.



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C. Motor Protection and Power Factor

It is the customer's responsibility to ensure that all motor circuits include protection which at a minimum meets the National Electrical Code and any applicable local codes. Note: such protection is designed to protect personnel from electrical and fire hazard, it is not intended to protect the motor from damage. For this reason, FPL recommends that the customer add the following to motor circuits to reduce the risk of equipment damage.

The use of automatic time delay circuit breakers or time delay fuses is strongly recommended when protecting motors against damage from excessive currents. The time delay feature will eliminate unnecessary operation of the breakers or blowing of fuses during motor starting or temporary overloads.

Under Voltage Protection - A low-voltage release is designed to disconnect the motor automatically and return the starting device to the "off" position upon partial or total failure of the supply voltage. It is used, where applicable, for motors that cannot safely be subjected to full voltage at starting, or where low voltage would result in injury or damage to equipment. This release should be of the time delay type, capable of adjustment to a maximum of at least two seconds and set at the lowest value suitable for proper protection. FPL will be glad to advise the Customer on the proper interval for coordination with FPL's circuit breakers. This will prevent unnecessary disconnection of the motor on momentary voltage fluctuations or loss of voltage.

Single Phase Protection - When installing three phase motors, the Customer should consider the possibility of the loss of one phase, either in his own installation or in FPL's supply lines. This "single phasing" may happen regardless of the precautions taken to avoid it, and FPL therefore strongly recommends that devices be installed to protect the equipment against the damage that may result.

Phase Reversal Protection - Three phase motors for applications to elevators, cranes, hoists, well pumps or other installations where reversal of rotation might cause damage to equipment or constitute a hazard to personnel ***should have phase rotation protection.***

Reclose Protection - Motors which cannot be safely subjected to full voltage starting, or processes which may create a safety hazard upon an uncontrolled re-start, should be designed to require manual or time delay re-start upon the interruption of the supply voltage.

Phase Imbalance Protection – Imbalanced three phase voltages may cause unequal phase currents. Heating caused by the imbalanced currents can shorten the life of a motor. Because of this, the American National Standards Institute, ANSI C84.1-2006 Standard for Power Systems and Equipment, recommends that "electric supply systems be designed and operated to limit the maximum voltage imbalance to 3 percent when measured at the electric-utility revenue meter under no-load conditions".

ANSI uses the formula:

Percent Imbalance = Maximum deviation from the average divided by the average

To protect motors from damage due to amperage imbalance, imbalance protection should be installed at the motor to limit full load operation if the voltage imbalance exceeds 3%, or the amperage imbalance exceeds 30%.

Note: Some brands of protection on the market for chillers and other motors use the formula:

Percent Imbalance = (Highest phase – lowest phase) divided by the average



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Devices using this formula should be set at 4% voltage and 40% amperage to provide the same protection as the ANSI formula.

Under voltage, single phase, phase reversal and imbalance protection are all available through the installation of an electronic phase loss protector in the motor control circuit. Such protective devices are supplied and installed by the Customer. FPL is not responsible for damage to motors from power abnormalities.

Surge protection should also be considered for installation at the motor breaker panel. Surge protection can help reduce damage to a motor's windings from external spikes, as well as reduce damage to customer equipment from power spikes generated by large motors starting and stopping.

Power Factor

Power factor is a calculation representing the relationship of "real" power (kw) which performs useful work in turning a motor, to "apparent" power (kva) which magnetizes motor and transformer coils. Motor loads frequently adversely affect the power factor of a circuit, usually from oversized or lightly loaded motors. Certain other types of loads can reduce power factor. A low power factor also reduces the capacity of circuit conductors to deliver "real" power and can increase wiring costs as well as electric demand on the utility system. FPL reserves the right to adjust meter reading kw for billing where power factor is less than 85%.

Capacitors are sometimes connected on the load side of a motor controller to improve the power factor of the circuit. When this is done, the total kvar connected should not exceed the value required to raise the power factor of the motor to unity when it is running unloaded.

D. Air Conditioners that require excessive starting currents

A number of single phase 240 volt air conditioning units currently on the market require starting currents that exceed the 40 amps per ton allowed by FPL design practices. This will cause voltage flicker (momentary voltage dips) to exceed the limits to which FPL's distribution systems have been designed, and in many cases, flicker conditions quite objectionable to homeowners having these units.

Air conditioning units causing the majority of complaints seem to be those with the "scroll" type compressor, that are 3 tons or greater. Unlike their predecessor reciprocating compressor types, these systems do not require a starting capacitor system to start, so the manufacturers are no longer installing them. Without starting capacitors, the starting currents drawn on the electrical distribution system and "seen" by the customer as flicker have increased dramatically.

We strongly suggest you verify, before purchasing, that the units you obtain require starting currents of 40 amps or less per ton. If these limits are exceeded, "hard start kits" should be installed. If further reductions are necessary, "delay start" mechanisms might be considered so all the units components (compressor, air handler, condensing fan) do not start simultaneously. Installing this equipment at the factory can be done for minimal cost (far less than retrofits in the field) and will prevent customer complaints. If FPL has to oversize new facilities or upgrade existing facilities due to starting currents exceeding the 40 amp per ton threshold, CIAC charges would apply.

Air conditioning manufacturers do not routinely publish starting current values. For units without



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starting capacitors a “rough” approximation of the starting current can be obtained by adding the Locked Rotor Amp (LRA) values for the compressor, condenser fan and air handler, and multiplying this total by 1.10. For further information on this subject contact your local FPL construction representative.