INSTALLATION INSTRUCTIONS
FOR
POWER FACTOR CORRECTION BANKS

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INSTALLING PFC CAPACITORS WITH MOTORS

OPERATING VOLTAGE:

Check the capacitor nameplate for the voltage, phase and frequency to ensure operating system compatibility. **The maximum RMS voltage at 60 HZ that can be applied to a capacitor assembly is 100% of the nameplate voltage, including harmonics but not transients.** A lower voltage may be applied with no harm to the capacitor; however, the KVAR will be reduced by a factor of the square of the operating voltage divided by the square of the nameplate voltage. **Operating a 240 volt capacitor at 208 volt yields only 75% of the nameplate KVAR rating, unless the capacitor is derated for 208 volt operation.**

LOCATION:

Figure 1A is usually the location to install the capacitor for new motor installations. Due to the reduced current, the overload heater element will have to be checked for proper sizing (Ref. NEC Sec. 460.9). This may be determined by using the nominal amperage of the KVAR capacitor assembly and subtracting it from the FLA rating of the motor.

Figure 1B is usually the location to install the capacitor for existing motor installations. Connecting the capacitor in this manner eliminates the need to resize the overload relay. At both Figure 1a and 1b locations, the capacitor is only on when the motor is on and does not require a separate fusible safety switch. **Application problems when applying capacitors to motors may be avoided by following a few simple rules. Do not apply capacitors on the load side of the motor starter when:**

1. **The load may drive the motor. (Examples are cranes and elevators)**
2. **Motors are subject to reversing, inching, jogging, and plugging.**
3. **Starters are multi-speed, open transition, and solid state.**

Power Factor Correction capacitors may be connected to the start winding on part-winding motors. **Variable frequency drives (SCR) create harmonics. Do not install capacitors across them. Consult the factory for recommendations.**

Figure 1C requires a separate fusible safety switch or circuit breaker when the capacitor is installed as indicated.

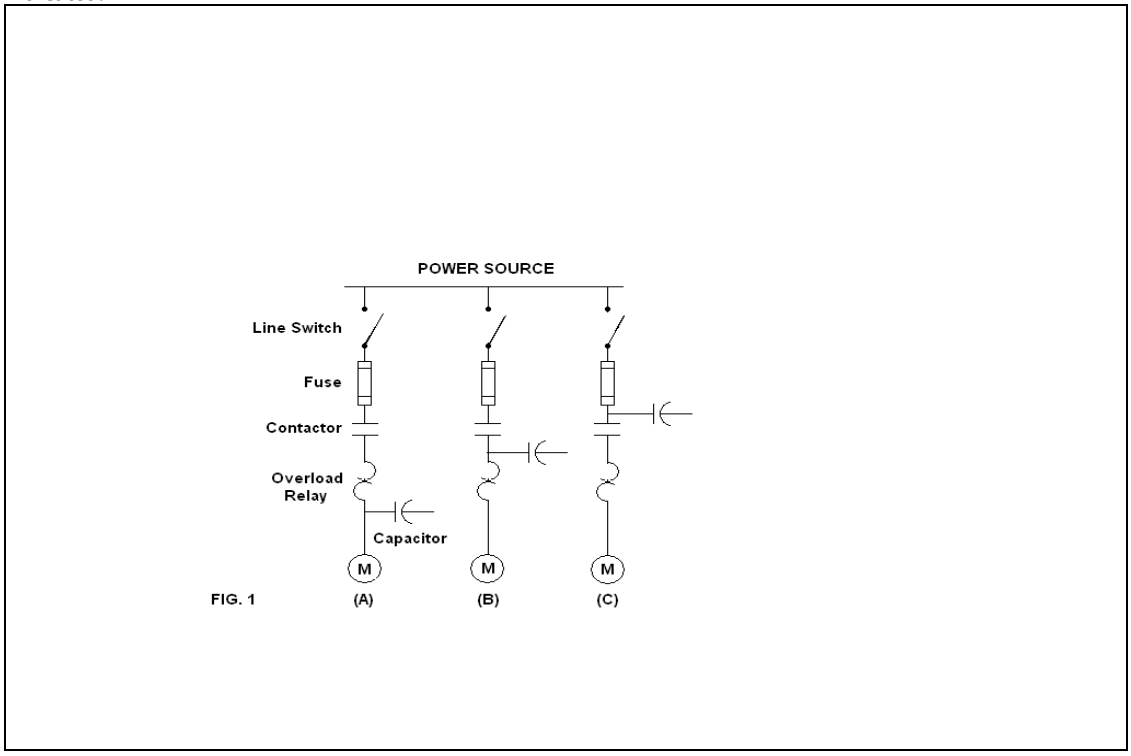


FIG. 1

INSTALLING PFC CAPACITORS WITH MOTORS

WIRE SIZE:
A minimum wire ampacity should be 135% of the rated Nominal Current of the capacitor assembly. The 135% figure is used to include the possibility of excess current due to over capacitance (0 to 15%), over voltage (0 to 10%), and harmonic currents in the system. The sum of these over currents should not exceed 135% of the capacitor assembly's rated Nominal Current.
The capacitor line current can be determined by the following formulas:

For 3 PH 60 HZ: $$I = \frac{KVAR \times 1000}{Volts \times 1.732}$$

For 1 PH 60 HZ: $$I = \frac{KVAR \times 1000}{Volts}$$

Where: I = Capacitor Rated Current
KVAR = Total Capacitor KVAR
Volts = Line to Line Voltage

POWER FACTOR WIRING CHART & INSTALLATION GUIDE

LOCATION

Greatest benefits are obtained when the correction capacitor is connected directly to the terminals of the motor. Not only is the system capacity increased and voltage levels improved, but motor losses substantially reduced. Where wiring is being overloaded by induction motors, power factor correction can reduce the need for a new wiring job.

Placing the capacitor at the motor insures switching both motor and capacitor on and off together. With this method extra switches are not needed to switch the capacitor as the motor is operated, it being accomplished with the motor control. Installation of the capacitor on the load side of the motor magnetic starter eliminates the need for other switches and fuses. Capacitors not installed in this manner are required by the National Electric Code to be equipped with a disconnect means.

ADVANTAGES/DISADVANTAGES OF INDIVIDUAL, FIXED BANKS AND AUTOMATIC BANKS

METHOD	ADVANTAGES	DISADVANTAGES
INDIVIDUAL BANKS	FLEXIBLE AND MOST EFFICIENT	HIGHER INSTALLATION COSTS
FIXED BANKS	MOST ECONOMICAL, FEWER INSTALLATIONS	REQUIRES SWITCHING DEVICES AND LESS FLEXIBLE

METHOD	ADVANTAGES	DISADVANTAGES
AUTOMATIC BANKS	LOW INSTALLATION COST, HANDLES VARIABLE LOADS PREVENTS OVERVOLTAGES.	HIGHER OVERALL EQUIPMENT COSTS.
COMBINATION OF	MOST PRACTICAL FOR LARGE PLANTS WITH NUMEROUS MOTORS.	

3-PHASE WIRING AND FUSING

	208 VOLTS				240 VOLTS				480 VOLTS				600 VOLTS			
KVAR*	NOM. AMPS.	SIZE THW WIRE	FUSE	Switch*	NOM. AMPS.	SIZE THW WIRE	FUSE	Switch*	NOM. AMPS.	SIZE THW WIRE	FUSE	Switch*	NOM. AMPS.	SIZE THW WIRE	FUSE	Switch*
1	2.7	14	4.5	30	2.4	14	5	30	1.2	14	5	30				
2.5	6.9	14	12	30	6.0	14	10	30	3.0	14	5	30	2.4	14	5	30
3	8.3	14	15	30	7.2	14	15	30	3.6	14	10	30	3.0	14	5	30
4	11.1	12	20	30	9.6	14	20	30	4.8	14	10	30	3.8	14	10	30
5	13.9	12	25	30	12.0	12	20	30	6.0	14	10	30	4.8	14	10	30
6	16.7	10	30	30	14.4	12	25	30	7.2	14	15	30	5.7	14	10	30
7.5	20.8	10	35	60	18.0	10	30	30	9.0	14	20	30	7.0	14	15	30
8	22.2	8	40	60	19.2	10	35	60	9.6	14	20	30	7.6	14	15	30
10	27.8	8	50	60	24.0	8	40	60	12.0	12	25	30	9.5	14	20	30
13	36.1	8	60	60	31.2	6	50	60	15.6	10	30	30	12.2	12	20	30
15	41.6	6	70	100	36.0	6	60	60	18.0	10	30	30	14.2	12	25	30
18	50.0	4	90	100	43.4	4	80	100	21.7	10	35	60	17.3	10	30	30
20	55.5	4	100	100	48.0	4	80	100	24.0	8	40	60	19.0	10	35	60
21	58.3	4	100	100	50.5	4	80	100	25.2	8	40	60	20.1	10	40	60
23	63.8	3	110	200	55.2	3	90	100	27.6	8	50	60	22.8	10	40	60
25	69.4	3	125	200	60.0	2	90	100	30.0	6	60	60	23.8	8	40	60
26	72.2	3	125	200	62.5	2	90	100	31.2	6	60	60	24.8	8	40	60
30	83.3	2	150	200	72.0	2	125	200	36.0	6	60	60	28.8	8	50	60
33	91.6	1	175	200	79.2	1	150	200	39.6	6	80	100	31.3	6	60	60
35	97.2	1/0	175	200	84.0	1	150	200	42.0	4	80	100	33.6	6	60	60
37	102.7	1/0	175	200	88.8	1/0	150	200	44.4	4	80	100	35.1	6	60	60
40	111.0	1/0	200	200	96.0	1/0	175	200	48.0	4	80	100	38.0	6	80	100
45	125.0	1/0	225	400	108.0	2/0	200	200	54.0	3	90	100	42.7	4	80	100
50	138.8	2/0	250	400	120.0	2/0	200	200	60.0	2	90	100	47.6	4	80	100
55	152.7	3/0	250	400	132.0	3/0	225	400	66.0	2	100	100	52.4	3	90	100
60	166.5	3/0	300	400	144.0	3/0	250	400	72.0	2	125	200	57.6	3	90	100
65	180.4	4/0	300	400	156.0	3/0	250	400	78.0	1	150	200	62.4	2	90	100
70	194.3	250	350	400	168.0	4/0	300	400	84.0	1	150	200	66.2	2	100	100
75	208.2	250	350	400	180.0	250	300	400	90.0	1/0	150	200	71.0	2	125	200
80	222.1	300	400	400	192.5	250	350	400	96.0	1/0	175	200	77.0	1	150	200
85	235.9	300	400	400	204.5	250	350	400	102.0	1/0	175	200	81.0	1	150	200
90	249.8	350	450	600	216.5	300	400	400	108.0	2/0	200	200	85.5	1/0	150	200
95	263.7	400	450	600	228.5	300	400	400	114.0	2/0	200	200	90.0	1/0	150	200
100	277.6	400	500	600	240.6	350	400	400	120.0	2/0	200	200	95.0	1/0	175	200
125	346.9	600	600	600	300.7	500	500	600	150.0	3/0	250	400	119.0	2/0	200	200

Wire sized on National Electrical Code requirement of 135% of rated current.
***Separate switch not required when capacitor installed on load side of motor magnetic starter.**

Re: The sizing of the motor Overload Protection when using Power Factor Correction Capacitors

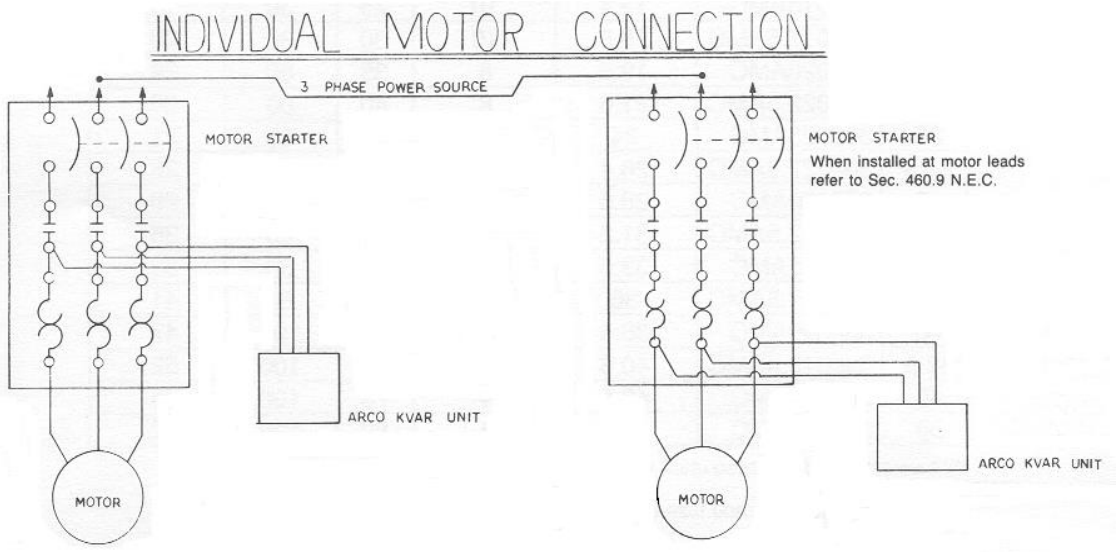
Ref. NEC Article 460.9

Article 460.9
Rating or Setting of Motor Overload Device

Where a motor installation includes a capacitor connected on the load side of the motor overload device, the rating or setting of the motor overload device shall be based on the improved power factor of the motor circuit.

The effect of the capacitor shall be disregarded in determining the motor circuit conductor rating in accordance with 430.2

Where a capacitor is connected on the load side of the overload relays, as shown in Exhibit 460.1, diagram (a), consideration must be given when selecting the rating or setting of the motor overload device because the line current will reduced due to an improved power factor. A value lower than that indicated in 430.32 should be used for proper protection of the motor.



Example #1 **Example #2**

When using the *Example #2* connection for the installation of the Power Factor Correction Bank, the overload sizing for the motor protection would determined by deducting the "Nominal Amperage" rating of the Power Factor Correction Bank from the recommended overload sizing for the motor load.

EXAMPLE

3 PH motor load
40 HP – 720 RPM - 480 VAC – FLA 55.1

PFC Bank required
22.5 KVAR – 480 VAC – 27 Nominal Amperage (Based on 1.2 Amps/ per KVAR at 480 VAC)

55.1 FLA of 3 PH motor load
\- 27 Nominal Amperage of PFC Bank
28.1 FLA of motor load after the current reduction changes created by adding the PFC Bank

The overload sizing for the motor would now require an adjustment in sizing based on the installation of the PFC Bank.

Note: The current reduction created by adding the PFC bank will be disregarded when determining the motor circuit conductor rating for the 3 PH motor load according to Article 460.9 of the NEC Code.