HOW TO CALCULATE WIRE AND FUSE SIZES FOR ELECTRIC MOTORS

Because electric motors have a tremendous amperage draw during the starting phase, wire and fuse sizes must be calculated very carefully. Even during the run cycle of a motor, if the voltage is low it will cause the motor to overheat and may cause failure. Electrical flow in a wire is similar to water flow in a pipe. If a short pipe is connected to an abundant water source with a constant pressure and a faucet and pressure gauge connected to the end, the gauge would hardly drop when the faucet is opened. But extend the pipe a considerable length and an extreme drop occurs during the test. The pressure drop is caused by the friction of the water moving against the stationary sides of the pipe. To achieve an adequate supply of water from the faucet, you would have to increase the size of the pipe so when the faucet was turned on only a slight variation in pressure occurs. The same principle applies to current in a wire.

When we connect a wire to a fuse or circuit breaker of proper size to handle the starting load requirements of a particular motor, we can test for voltage at the wire's end and will have the same voltage as at the fusing device. Hook the motor to the wire ends and turn it on. If the voltage drops considerably, the wire size is too small. Low voltage can cause the motor to fail.

Motors should be fused with a time-delay fuse rated 175% of the motor's full load operating amperage, 250% of the full load operating amperage if a circuit breaker is used. The wire to a motor must be rated to carry 25% more amperage than the motor draws when operating at full load. This amperage rating is listed on most motors. As stated earlier, it may be necessary to increase the wire by several sizes to compensate for voltage drop caused by excessive distances of the feeder run.

The chart on the opposite side gives fuse or breaker sizes for various sized motors that are common around the home, farm, and workshop. It also lists the maximum distances you can run various sized wires to service these motors. The distances in the chart represent, in feet, the distance from the primary service panel to the motor.

The chart is based on the formula:

$$V = \frac{2(R) \times (L) \times (I)}{1000}$$

Where "V" is voltage drop, "L" is the length of the run in feet, "R" is the resistance of the wire in ohms per thousand feet, and "I" the amount of current drawn in amperes. Voltage drop is based on 3%. Horsepower amperage from Table 430-248 and resistance of wires from Table 8, Chapter 9 of NFPA National Electrical Code. Fuse and breaker sizes are derived from motor data calculators published by major electrical manufacturers.

COMMON WIRE RESISTANCE*			
COPPER		ALUMINUM	
#10	1.26		
#8	0.786	#6	0.808
#6	0.510	#4	0.508
#4	0.321	#2	0.319
#2	0.201	#1	0.253
*in ohms per 1000 feet			

These "How-To-Do-It" sheets have been reviewed in June 2007 by a professional Engineer. If you find a problem, please notify G & G Electric & Plumbing at 1900 NE 78th Street, Ste. 101, Vancouver, Washington 98665

CHART TO DETERMINE FUSE / BREAKER AND WIRE SIZES FOR ELECTRIC MOTORS (For single phase A.C. motors only)

1. Select motor size from horsepower column making certain you are in the correct voltage.
2. Select fuse or breaker size from column 3 or 4.
3. Read horizontally to the right until the distance is as great or greater than your installation distance.
4. Go vertically to the head of that column for the recommended wire size.

NOTE!! If the motor is required to start under a heavy load, we recommend using one size larger wire.

VOLT	HORSE POWER	DUAL ELEMENT FUSE	CIRCUIT BREAKER	DISTANCE FROM SERVICE PANEL TO MOTOR (Including Vertical Distances)									
				COPPER WIRE						ALUMINUM WIRE			
				#12	#10	#8	#6	#4	#2	#8	#6	#4	#2
115V	1/3 HP	10 AMP	15 AMP	126 FT	201 FT	321 FT	509 FT	811 FT	1288 FT	195 FT	309 FT	492 FT	783 FT
	1/2 HP	15 AMP	20 AMP	92 FT	148 FT	236 FT	374 FT	596 FT	946 FT	143 FT	227 FT	361 FT	575 FT
	3/4 HP	20 AMP	25 AMP	65 FT *	105 FT	167 FT	265 FT	423 FT	672 FT	101 FT	161 FT	256 FT	408 FT
	1 HP	25 AMP	30 AMP		90 FT *	144 FT	229 FT	365 FT	579 FT	87 FT	139 FT	221 FT	352 FT
	1-1/2 HP	30 AMP	40 AMP		72 FT *	115 FT	183 FT	292 FT	463 FT	70 FT	111 FT	177 FT	282 FT
	2 HP	30 AMP	50 AMP		60 FT *	96 FT	152 FT	243 FT	386 FT	58 FT	92 FT	147 FT	235 FT
230V	1/3 HP	5.6 AMP	15 AMP	505 FT	806 FT	1285 FT	2036 FT	3246 FT	5154 FT	781 FT	1237 FT	1968 FT	3134 FT
	1/2 HP	7 AMP	15 AMP	371 FT	592 FT	944 FT	1496 FT	2385 FT	3787 FT	573 FT	909 FT	1446 FT	2303 FT
	3/4 HP	10 AMP	15 AMP	263 FT	420 FT	670 FT	1062 FT	1693 FT	2689 FT	407 FT	645 FT	1027 FT	1635 FT
	1 HP	12 AMP	15 AMP	227 FT	362 FT	578 FT	916 FT	1461 FT	2319 FT	351 FT	556 FT	885 FT	1410 FT
	1-1/2 HP	15 AMP	20 AMP	181 FT	290 FT	462 FT	733 FT	1168 FT	1855 FT	281 FT	445 FT	708 FT	1128 FT
	2 HP	20 AMP	25 AMP	151 FT *	241 FT	385 FT	611 FT	974 FT	1546 FT	234 FT	371 FT	590 FT	940 FT
	3 HP	25 AMP	35 AMP		170 FT *	272 FT	431 FT	687 FT	1091 FT	165 FT	262 FT	416 FT	663 FT
	5 HP	40 AMP	60 AMP			165 FT	261 FT	417 FT	662 FT		159 FT	253 FT	403 FT

* Fuses only

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