Sizing a Generator for a Specific Electric Motor Load, or for use with Large Extension Cords

Generator sizing becomes more difficult when electric motors are involved, due to their large starting demand. Typically, there are two motor styles: CODE G requires 3 times running watts to start, and CODE L requires 5 to 6 times running watts to start.

It is not practical to think that all loads will start at the same time. Nor is it practical to size a generator using all starting watts for all selected motors, as some motor loads will already be running (or OFF), when others are ready to start. As you can see, it can be difficult to exactly size a generator for a group of specific loads, as they are constantly changing in their "ON" or "OFF" cycle. Always try to limit your load selections to the bare essential items.

Following are (4) charts that will help in sizing large (over 1 hp) electric motor loads to be started by generator power. Use the instructions and examples, immediately following these charts, for actual generator sizing.

CHART A

NEMA CODE LETER	LOCKED ROTOR KVA/HP	NEMA CODE LETER	LOCKED ROTOR KVA/HP
A	0-3.14	L	9.0-9.9
B	3.15-3.54	M	10.0-11.19
C	3.55-3.99	N	11.2-12.49
D	4.0-4.49	P	12.5-13.99
E	4.5-4.99	R	14.0-15.99
F	5.0-5.59	S	16.0-17.99
G	5.6-6.29	T	18.0-19.99
H	6.3-7.09	U	20.0-22.39
J	7.1-7.99	V	22.4-UP
K	8.0-8.99		
NEMA STD. MG 1-10.36 JAN '84			

CHART B

NEMA CODE AND HP ESTIMATES

CODE	TYPICAL HP RANGE
F	15 HP & UP
G	10-12 HP
H	5-9 HP
J	3-4 HP
K	1.5-2.5 HP
L	1 HP
M	LESS THAN 1 HP

CHART C

ESTIMATED CODE G ELECTRIC MOTOR STARTING AND RUNNING WATTS

MOTOR HP	MOTOR RUN WATTS	MOTOR STARTING WATTS			
		UNIVERSAL MOTORS (SMALL APPLIANCES)	REPULSION INDUCTION MOTORS	CAPACITOR START MOTORS	SPLIT PHASE MOTORS
1/6	300	600	750	950	1500
1/4	400	800	1000	1300	2000
1/3	475	950	1185	1600	2400
1/2	650	1000	1600	2000	3200
3/4	900	1200	2200	2800	N/A
1	1000	N/A	2500	3200	N/A
1-1/2	1700	N/A	4200	5500	N/A
2	2000	N/A	5000	6800	N/A
3	3200	N/A	8000	10000	N/A

5	5000	N/A	12500	15000	N/A

CHART D		
TO FIND:	SINGLE PHASE	THREE PHASE
KILOWATTS KW	VOLTS X AMPS X P.F. / 1000	VOLTS X AMPS X 1.73 X .8 / 1000 = KVA X .8
KILO-VOLT-AMPS KVA	VOLTS X AMP / 1000	VOLTS X AMPS X 1.73 / 1000 = KW / .8
KW REQUIRED FOR MOTOR	MOTOR HP X EFF.	HP X .746 / EFFICIENCY
KVA REQUIRED FOR MOTOR	MOTOR HP X EFF. X .8	HP X .746 / EFFICIENCY X .8
POWER FACTOR P.F.	KW / KVA	KW / KVA
AMPS - WHEN KW IS KNOWN	(KW X 1000) / (VOLTS X P.F.)	(KW X 1000) / (1.73 X VOLTS x P.F.)
AMPS - WHEN KVA IS KNOWN	KVA X 1000 / VOLTS	(KVA X 1000) / (1.73 X VOLTS)
REQUIRED PRIME MOVER (ENGINE) HORSE POWER	KW / (GENERATOR EFF. X .746)	
FREQUENCY (HERTZ)	NUMBER OF POLES X R.P.M / 120	

CHART E			
WIRE GAUGE FOR EXTENSION CORDS			
LOAD AMPS	0 - 50 FEET	51 - 100 FEET	101 - 150 FEET
1-11	18	16	14
12-18	16	12	10
19-25	12	10	8
26-35	10	8	6
36-40	8	6	4
41-50	6	4	2
51-60	4	2	2

EXAMPLES IN GENERATOR SIZING FOR LARGE ELECTRIC MOTORS

All electric motors require large amounts of electric power to start up, due to it's starting winding. After approximately 3/4 - 1-1/2 seconds, the starting winding drops out, and the running winding continues, at a much lower power demand. A generator must be sized to handle the load of the starting winding.

Chart A determines a motor code letter (found on all motor nameplates), which allows calculation of starting amps, or better known as locked rotor amps (LRA). If motor code is not available, use Chart B for code estimate. Following are formulae and examples:

Sizing a generator for single phase motor starting LRA : The formula is: Motor HP x KVA per HP x (1000 / Motor Voltage) = LRA. Example: A 3/4 HP, Code L motor connected to 240 Volts, requires what LRA? Refer to Chart A, and find Code L. Always use the largest KVA/HP number, so select 9.9. The formula becomes: .75 x 9.9 x (1000/240) = 7.425x4.167 = 30.9 = 31 LRA. The generator must produce 31 Amps at 240 Volts, to safely start this motor. Multiply 31 amps x 240 Volts = 7400 Watts or 7.5 KW generator size.

Sizing a generator for three phase motor starting LRA : The formula is: Motor HP x KVA per HP x (1000 / (Volts x 1.73)) = LRA. Example: A 20 HP Code G motor connected to 460 Volts requires what LRA? Refer to Chart A and select 6.29 KVA/HP, from Chart A, for Code G. The formula becomes: 20 x 6.29 x (1000 / (460 x 1.73)) = 125.8 x 1.26 = 158.5 = 159 LRA. The generator must produce 159 Amps at 460 Volts, to safely start this motor. Use formula: 1.73 x Volts x Amps x .8 / 1000 for generator KW size.

BOTH SINGLE PHASE AND THREE PHASE MOTOR SIZING EXAMPLES ARE BASED ON INFORMATION IN NATIONAL ELECTRICAL CODE HANDBOOK, ARTICLE 430.7 AND IS INTENDED FOR MAXIMUM VOLTAGE DIP OF 25% UPON INITIAL MOTOR START-UP. IF 35% VOLTAGE DIP IS ALLOWABLE, REDUCE LRA, THEREFORE KW SIZE, BY 25% (LRA or KW X .75), WE DO NOT RECOMMEND ANY GENERATOR KW SIZING THAT YIELDS MORE THAN 35% VOLTAGE DIP.

Chart B can be used as a motor code estimate, when actual motor code is not available.

Chart C can be used as a quick reference for all Code G Motors.

Chart D shows various generator formulas that may be of use.

Chart E shows wire gauge for extension cords, used with various load amps and distances.

Starting more than one motor, at one time: make a list of all motors, totaling all running watts. Calculate the starting demand when the largest motor is started while all others are running. Add the largest motor starting watts, to the running watts of all smaller motors already running.
As shown by selection chart, air conditioning starting watts have the largest demand load. It may be wise to dis-card air conditioner use, during blackouts, to keep your generator kw size, smaller.

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