Technical Data **TD00405018E** Effective August 2009

Generator Sizing Guide

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Important Notice:

This booklet is designed to familiarize estimators and installers with proper sizing guidelines for residential and commercial generators. The information is not comprehensive, nor does it replace or supercede any material contained in any of the written documents shipped with the equipment. This booklet should only be used in conjunction with the Owner's Manual, Installation Manual and other technical documents shipped with each product. Always read all accompanying documentation carefully before attempting to install any generator, transfer switch or related equipment.

How To Use This Booklet:

Within this booklet, you will find electrical load information, plus an outline of generator surge capability, fuel pipe sizing, liquid propane tank sizing, and UPS / generator compatibility. The worksheet pages can be removed from the book and photocopied to create additional Onsite Estimating Sheets for use with individual jobs.

Safety Information:

Proper sizing of the generator is crucial to the success of any installation and requires a good working knowledge of electricity and its characteristics, as well as the varying requirements of the electrical equipment comprising the load. When analyzing the electrical load, consult the manufacturer's nameplate on each major appliance or piece of equipment to determine its starting and running requirements in terms of watts, amps and voltage. When choosing the generator output for commercial or industrial applications, select a rating that is approximately 20 to 25% higher than the peak load (for example, if the load is about 40 kilowatts, select a 50 kW genset). A higher rated generator will operate comfortably at approximately 80% of its full capacity and will provide a margin of flexibility if the load increases in the future.

For safety reasons, Eaton recommends that the backup power system be installed, serviced and repaired by an Eaton Authorized Service Dealer or a competent, qualified electrician or installation technician who is familiar with applicable codes, standards and regulations.

It is essential to comply with all regulations established by the Occupational Safety & Health Administration (OSHA) and strict adherence to all local, state and national codes is mandatory. Before selecting a generator, check for municipal ordinances that may dictate requirements regarding placement of the unit (setback from building and/or lot line), electrical wiring, gas piping, fuel storage (for liquid propane or diesel tanks), sound and exhaust emissions.

If you have a technical question regarding sizing or installation, contact Eaton's Technical Service Center toll free at 1-800-975-8331 during normal business hours (8 a.m. to 4 p.m. CST).

Table 1. Motor Load Reference

AC & Heat Pumps		Running Load					Starting Load				
Description	**Hp**	**Running kW**	**Amps @ 240V 1Ø**	**Amps @ 208V 3Ø**	**Amps @ 240V 3Ø**	**Amps @ 480V 3Ø**	**LR Amps @ 240V 1Ø**	**LR Amps @ 208V 3Ø**	**LR Amps @ 240V 3Ø**	**LR Amps @ 480V 3Ø**	**kW**
1 Ton (12,000 BTU)	1	1	5	3	3	1	33	22	19	10	2.5
2 Ton (24,000 BTU)	2	2	10	7	6	3	67	44	38	19	5
3 Ton (36,000 BTU)	3	3	15	10	8	4	100	67	58	29	7.5
4 Ton (48,000 BTU)	4	4	20	13	11	6	117	78	67	34	10
5 Ton (60,000 BTU)	5	5	25	16	14	7	145	97	84	42	12.5
7.5 Ton (85,000 BTU)	7.5	7.5	37	24	21	11	219	146	126	63	17
10 Ton* (120,000 BTU)	5 (x2)	10	49	33	28	14	145	97	84	42	12.5
10 Ton (120,000 BTU)	10	10	49	33	28	14	250	167	144	72	20
15 Ton* (180,000 BTU)	7.5 (x2)	15	74	49	42	21	219	146	126	63	17
15 Ton (180,000 BTU)	15	15	74	49	42	21	375	250	217	108	30
20 Ton* (240,000 BTU)	10 (x2)	20	98	65	57	28	250	167	144	72	20
20 Ton (240,000 BTU)	20	20	N/A	65	57	28	500	333	289	144	40
25 Ton (300,000 BTU)	25	25	N/A	82	71	35	625	416	361	180	50
30 Ton* (360,000 BTU)	15 (x2)	30	N/A	98	85	42	375	250	217	108	30
30 Ton (360,000 BTU)	30	30	N/A	98	85	42	750	500	433	217	60
40 Ton* (480,000 BTU)	20 (x2)	40	N/A	131	113	57	500	333	289	144	40
40 Ton (480,000 BTU)	40	40	N/A	131	113	57	1000	666	577	289	80
50* Ton (480,000 BTU)	25 (x2)	50	N/A	163	142	71	625	416	361	180	50
50 Ton (480,000 BTU)	50	50	N/A	163	142	71	1250	833	722	361	100

General Residential

Description	**Hp**	**Running kW**	**Amps @ 120V 1Ø**	**4.9 Amps @ 240V 1Ø**	**LR Amps @ 240V 1Ø**	**LR Amps @ 120V 1Ø**		**kW**
Refrigerator pump, sump, furnace, garage opener	0.5	0.5	4.9	2.5	13	25		1.5
Freezer, washer, septic grinder	0.75	0.75	7.4	3.7	19	38		2.3
General 1 Hp	1	1	9.8	4.9	25	50		3
Well & septic lift pump	2	2	19.6	9.8	50	100		6

* For multiple motor configurations, sequence starting is assumed.

Caution:
Do not size the generator based on starting kW alone.
You must compare LR Amps to generator surge capability (table #3).
Size the generator by following the sizing instructions.

Table 2. Non - Motor Load Reference

Residential			
	Running Load*		
Description	**Running kW**	**Amps @ 120V 1Ø**	**Amps @ 240V 1Ø**
Electric heat per 1000 ft2	12	N/A	50
Heat pump elements per 1000 ft2	7	N/A	29
Dryer	5.5	N/A	23
Hot tub	10	N/A	50
Range oven/Stove top per burner	8	N/A	30
Hot water	4.5	N/A	19
General lighting and receptacles per 1000 ft2	3	24.9	N/A
Blow dryer	1.25	10.4	N/A
Dishwasher	1.5	12.5	N/A
Microwave	1	8.3	N/A
Toasters	1	8.3	N/A
Home Entertainment Center	1	8.3	N/A
Computer	1	8.3	N/A
Kitchen	1.5	12.5	N/A
Laundry	1.5	12.5	N/A

Commercial

Please refer to equipment data plate and/or billing history for commercial details

* Always check data plate for actual running amps.

Table 3. Surge Capability

Generators (Operating at less than 3600 RPM)												
	Rated Output (Running Amps)				Commercial (LR Amps @ 15% Voltage Dip)				Residential (LR Amps @ 30% Voltage Dip)			
Size (kW)	240V 1Ø	208V 1Ø	240V 3Ø	480V 3Ø	240V 1Ø	208V 1Ø	240V 3Ø	480V 3Ø	240V 1Ø	208V 1Ø	240V 3Ø	480V 3Ø
22	92	76	N/A	N/A	71	48	N/A	N/A	134	92	N/A	N/A
25	104	87	75	38	71	48	46	30	138	92	91	59
27	113	94	81	41	100	67	58	33	153	137	118	64
30	125	104	90	45	100	67	65	43	205	137	130	87
35	146	121	105	52	113	75	60	43	225	150	118	87
36	150	125	108	54	113	75	65	44	225	151	131	87
40	167	139	120	60	129	86	75	49	254	169	147	97
45	188	156	135	68	146	98	94	57	292	195	168	112
48	200	167	144	72	163	109	94	57	321	214	185	112
70	292	243	210	105	275	164	159	95	550	330	318	190
80	333	278	240	120	275	183	159	106	550	366	318	212
100	417	347	300	150	369	222	214	128	738	441	426	255
130	542	451	390	195	546	364	315	209	1088	724	628	419
Generators (Operating at 3600 RPM)												
7	29	N/A	N/A	N/A	23	N/A	N/A	N/A	46	N/A	N/A	N/A
8	33	N/A	N/A	N/A	26	N/A	N/A	N/A	51	N/A	N/A	N/A
10	42	N/A	N/A	N/A	31	N/A	N/A	N/A	63	N/A	N/A	N/A
13	54	N/A	N/A	N/A	48	N/A	N/A	N/A	95	N/A	N/A	N/A
14	58	N/A	N/A	N/A	52	N/A	N/A	N/A	102	N/A	N/A	N/A
16	67	N/A	N/A	N/A	59	N/A	N/A	N/A	117	N/A	N/A	N/A
17	71	N/A	N/A	N/A	63	N/A	N/A	N/A	125	N/A	N/A	N/A
18	75	N/A	N/A	N/A	67	N/A	N/A	N/A	133	N/A	N/A	N/A
20	83	N/A	N/A	N/A	73	N/A	N/A	N/A	145	N/A	N/A	N/A
25	104	87	75	38	71	48	46	30	138	92	91	60
30	125	104	90	45	100	67	60	43	205	137	130	87
35	146	121	105	52	113	75	60	43	225	150	118	87
45	188	156	135	68	146	98	94	57	292	195	168	112
60	250	208	180	90	179	120	103	69	350	234	204	136
70	292	243	210	105	275	164	142	95	550	330	286	190
80	333	278	240	120	275	183	158	106	550	366	318	212
100	417	347	300	150	369	222	214	128	738	441	426	255
150	625	520	451	226	558	372	322	215	1121	747	647	431

Note: All nominal ratings based upon LP fuel. Refer to specification sheet for NG ratings and deration adjustments for ambient temperature and altitude.

Table 4. Fuel Pipe Sizing

Natural Gas (Values are maximun pipe run in ft.)							
	Pipe Size (in)						
kW	0.75"	1"	1.25"	1.5"	2"	2.5"	3"
7-8	55	200	820				
10	20	85	370	800			
13-14	10	50	245	545			
16-17		40	190	425			
20		20	130	305	945		
22		15	115	260	799		
25		10	95	220	739		
27			85	203	552		
30			60	147	565		
35-36			35	95	370	915	
40			25	75	315	790	
45			15	60	260	650	
48				50	230	585	
50				50	220	560	
60				25	145	390	1185
70				5	75	225	710
80					65	195	630
100					40	140	460
130						50	215
150						30	150

LP Vapor (Values are maximun pipe run in ft.)

	Pipe Size (in)						
kW	0.75"	1"	1.25"	1.5"	2"	2.5"	3"
7-8	165	570					
10	70	255	1000				
13-14	45	170	690				
16-17	25	130	540				
20	15	115	480				
22		85	365				
25		60	275	605			
27		55	260	575			
30		40	195	435			
35-36		20	125	290	1030		
40		15	107	250	890		
45			82	195	725		
48			70	165	620		
50			70	160	610		
60			45	115	445	1095	
70			20	60	260	660	
80			15	50	230	590	
100				30	165	430	1305
130					70	205	660
150					45	150	490

LP
- LPG: 8.55 ft^3/lb., 4.24 lbs./gal., 2500 btu/ft^3
- LPG: 36.3 ft3 = 1 gal.

Natural Gas
- 1 cubic foot = 1,000 BTU.
- 1 therm = 100,000 BTU.
- Gas consumption = 13,000-16,000 BTU per kW/hr.

Pressure
- 1 inch mercury = 13.61 inches water column.
- 1 inch Water Column = 0.036 psi.
- 5-14 inches water column = 0.18 psi to 0.50 psi.

Note:
- Pipe sizing is based on 0.5" H_2O pressure drop.
- Sizing includes a nominal number of elbows and tees.
- Please verify adequate service and meter sizing.

Table 5. LP Vapor (LPV) Tank Sizing

Vapor Withdrawal (Dimensions are given in inches)						
Tank Capacity Total (Gal.)	**Tank Capacity Useable (Gal.)**	**Minimum Temp (°F)**	**Tank Capacity (btu/hr.)**	**Length**	**Diameter**	**Overall Ht.**
120	72	40 20 0	246,240 164,160 82,080	57	24	33
150	90	40 20 0	293,760 195,840 97,920	68	24	33
250	150	40 20 0	507,600 338,400 169,200	94	30	39
325	195	40 20 0	642,600 428,400 214,200	119	30	39
500	300	40 20 0	792,540 528,360 264,180	119	37	46
850	510	40 20 0	1,217,700 811,800 405,900	165	41	50
1000	600	40 20 0	1,416,960 944,640 472,320	192	41	50

Load (kW)	BTU / Hr	LP Gal / Hr	NG Ft^3 / Hr	NG Therms/ HR
5	110,000	1.2	110	1.1
10	176,400	2	156	1.6
15	231,800	2.5	220	2.2
20	267,100	2.8	262	2.6
25	352,800	3.8	316	3.2
30	418,300	4.5	417	4.2
35	467,400	5.1	485	4.8
40	550,000	6.1	550	5.5
50	675,000	7.5	675	6.7
60	836,600	9	862	8.6
70	1,035,700	11	1,020	10.2
80	1,170,000	12.7	1,154	11.5
90	1,200,000	13	1,200	12
100	1,280,000	13.8	1,260	12.6
110	1,550,000	17.1	1,550	15.5
120	1,675,000	18.5	1,675	16.7
130	1,800,000	19.5	1,786	17.8
140	1,925,000	21.3	1,925	19.2
150	2,050,000	22.7	2,050	20.5
200	2,800,000	30.9	2,800	28.0
300	4,100,000	45.3	4,100	49.0

Gas Required For Common Appliances	
Appliance	**Approximate Input (btu/hr.)**
Warm Air Furnace Single Family Multifamily, per unit	 100,000 60,000
Hydronic Boiler, Space Heating Single Family Multifamily, per unit	 100,000 60,000
Hydronic Boiler, Space and Water Heating Single Family Multifamily, per unit	 120,000 75,000
Range, Free Standing, Domestic Built-In Oven or Broiler Unit, Domestic Built-In Top Unit, Domestic	65,000 25,000 40,000
Water Heater, Automatic Storage, 30 to 40 gal. Tank Water Heater, Automatic Storage, 50 gal. Tank Water Healer, Automatic Storage, Instantaneous 2 GPM 4 GPM 6 GPM Water Heater, Domestic, Circulating or Side-Arm	35,000 50,000 142,800 285,000 428,000 35,000
Refrigerator Clothes Dryer, Type 1 (Domestic) Gas Fireplace Direct Vent Gas log Barbecue Gas light Incinerator, Domestic	3,000 35,000 40,000 80,000 40,000 2,500 35,000

Operating Cost Per Hour	= NG Therms/HR x Cost of NG Therm

Note: Tank BTU capacity and generator run times based upon maintaining a minimum tank fuel level of 20%. Tanks are typically filled to 80% full. Typical fuel consumption based on a generator 100% loaded.

UPS - GENERATOR COMPATIBILITY

Passive (also referenced as standby or off-line) and Line-Interactive

These technologies are most common for personal workstations and point of sale applications. They are typically single phase equipment with size ranges of 350 VA - 2000 VA for passive and 500 VA to 5000 VA for line-interactive.

Passive UPS's are the simplest type. Under normal conditions AC power passes straight through to the UPS load. When the input power supply goes outside of specifications, the UPS transfers the load from input power to the internal DC to AC power inverter. Passive UPS's do not correct for voltage or frequency deviations under "normal" operation.

Line-interactive is similar to the passive technology except it has circuitry that attempts to correct for standard voltage deviations. Frequency deviations under "normal" power operation are not corrected.

Equipment Notes:

These devices tend to be electrically / harmonically very noisy. A single small UPS is not a significant concern, but applications with multiple UPS's can be problematic.

Passive UPS technology typically has normal tolerances of 10-25% on voltage and 3 hertz on frequency. If the input source goes outside of these tolerances, the UPS will switch onto the UPS battery source. Some line-interactive units may have frequency tolerances factory set to 0.5 hertz. These units will need to have their frequency tolerance increased to a minimum of 2 hertz.

Generator Sizing Recommendation:

- Limit the total UPS loading to 15% - 20% of the generator capacity.

Double-Conversion

This technology is most common for critical load applications. Double-conversion UPS's constantly rectify AC to DC and then invert the DC back into AC. This configuration results in an output that corrects for voltage and frequency deviations.

There are single and three phase models covering small through large applications. Most UPS applications larger than 5000 VA use double conversion technology. This approach is also the preferred technology for generator applications.

Equipment Notes:

Double-conversion UPS's that are single phase or unfiltered three phase models tend to create a significant level of electrical/ harmonic noise. This is illustrated by harmonic current distortions that are greater than 35%. Minuteman UPS products could have current distortion of 8%. When three phase models are supplied with harmonic filters (current distortion less than 10%), this concern is no longer an issue.

Generator Sizing Recommendation:

- Single phase models: Limit the total UPS loading to 25% of the generator capacity.
- Single phase Minuteman UPS models: Limit the total UPS loading to 50% of the generator capacity.
- Three phase models without filters (current distortion > 30%): Limit the UPS loading to 35% of the generator capacity.
- Three phase models with filters (current distortion < 10%): Limit the UPS loading to 80% of the generator capacity.

Supplier(s)	Passive (Standby)	Line-Interactive	Double-Conversion
Powerware	3000 series	5000 series	9000 series
Minuteman UPS	Enspire	Enterprise Plus	Endeavor
APC	Back-UPS Series	Smart-UPS Series	Symmetra Series
Liebert	PowerSure PST & PSP	PowerSure PSA & PSI	UPStation & Nfinity

Onsite Estimating Sheet

Contractor_____ Email_____

Phone_____ Fax_____

Job Name_____

Date_____ Location_____

VOLTAGE ☐ 120/240 1ø ☐ 120/208 3ø ☐ 120/240 3ø ☐ 277/480 3ø

TYPE ☐ Natural Gas ☐ LP Vapor (LPV)

ELEC. SERVICE ☐ 100 Amp ☐ 200 Amp ☐ 400 Amp ☐ 600 Amp ☐ Other_____

Before installation contact local jurisdiction to confirm all requirements are met. Jurisdictions may vary. Eaton recommends contacting local authorities prior to installation.

Loads: Look for heavy building loads such as refrigeration, air conditioning, pumps or UPS systems.

Motor Load Table (Refer to Table 1) Use the following for sizing and determining generator kW.

Device	HP	RA	LRA	kW Rnning (= HP)	Starting kW

- Starting kW for HP < 7.5 starting kW = HP x 3
- Starting kW for HP > 7.5 starting kW = HP x 2
- Starting kW for loading with no listed HP, calculate HP based on running amps in the chart on the right

Non-Motor Load Table (Refer to Table 2) Use the following for sizing and determining generator kW.

Device	Amps	kW

Install notes:

- Suggested concrete pad minimum thickness of 4" with 6" overhang on all sides. Composite pad included with air-cooled products.
- Consult manual for installation recommendations.
- Consult local authority having jurisdiction for local requirements.

Transfer Switch Avalability	
Single Phase*	**Amps**
Service Entrance	100, 200, 400, 600, 800
Non-Service Entrance	50, 100, 200, 400, 600, 800
Three Phase	
Service Entrance	100, 225, 300, 400, 600, 800
Non-Service Entrance	100, 200, 300, 400, 600, 800

***** Single Phase ATS's from 100-400 Amp have intelligent load management standard.

To Calculate kW	
120 V 1ø	Amps x 120/1000 = kW
240 V 1ø	Amps x 240/1000 = kW
208 V 3ø	(Amps x 208 x 1.732 x PF) /1000 = kW
240 V 3ø	(Amps x 240 x 1.732 x PF) /1000 = kW
480 V 3ø	(Amps x 480 x 1.732 x PF) /1000 = kW

Recommended Generator Size _____

Refer to Generator Sizing Instructions on other side of this sheet.

Applications

The QT Series does not meet the necessary requirements for the following applications:

- NEC 695 Fire Pumps
- NEC 700 Emergency Systems
- NFPA 20 Fire Pumps
- NFPA 99 Healthcare
- NFPA 110 Emergency Systems

Reference Codes

Related Codes and Standards:

- NEC 225 Branch Circuits and Feeders
- NEC 240 Overcurrent Protection
- NEC 250 Grounding
- NEC 445 Generators
- NEC 700 Emergency Systems
- NEC 701Legally Required Standby
- NEC 702 Optional Standby
- NFPA 37 Installation & Use of Stationary Engines
- NFPA 54 National Fuel Gas Code
- NFPA 58LP Gas Code

Onsite Estimating Sheet

Generator Sizing Instructions:
There is not a single correct sizing solution. Following are several methods that, when mixed with good judgement, should result in an appropriately sized generator. Remember to consider load growth, seasonality, and effects of starting motors.

As municipalities and states adopt the new 2008 NEC Electrical Code, there may be new sizing requirements, spelled out in the code book, which the installation technician must follow. Always check with the local inspection department to confirm which code cycle will affect your install.

Never add Amps when sizing a generator. Convert Amps to kW and add kW to determine the required generator size. Power factors for various motor loads vary widely. Adding Amps without properly accounting for the power factor and/or mixing voltages will result in improperly sizing the generator.

When motors start, they create a current surge that step loads the generator and creates a voltage dip. After selecting a generator, reference the generator's surge capability using table 3. Verify that voltage dip is adequate for the application. Most commercial applications should be limited to about 15% voltage dip and residential applications should be limited to a 30% voltage dip. Some applications utilize an uninterruptible power supply (UPS) to back up critical loads. Please read sizing guide for this load type.

Measurement Method
Use a clamp-on Amp meter or power analyzer to measure facility load levels. Clamp each leg separately and take the measurement during peak usage levels.

240V 1ø Applications: To determine peak usage in kW, add the highest Amp readings from the two legs, multiply by 120 and divide by 1,000.

(L1 + L2)120 / 1000

Size the generator 10 to 20% larger than the peak measured load.

3ø Applications: Add the peak Amp readings from all three legs and divide by 3 to determine peak Amps. Multiply peak Amps by volts, multiply the result by 1.732 (square root of 3), then divide by 1000 to convert Amps to kW.

Peak Amps = (L1 + L2 + L3) / 3
kW = [(Peak Amps x Volts) x 1.732] / 1000*
*Assumes power factor of 1.0
Size the generator 20 to 25% larger than the peak measured load.

Peak Amps = _____ Peak kW= _____

Billing History Method Commercial
Many commercial customers have a utility rate structure that has a peak demand charge. Using a year's worth of electric bills, size the generator 25% larger than the largest peak demand.

Verify motor and UPS load compatibility: Peak Demand = _____

Load Summation Method

- Enter running kW for all motor loads (except the largest) expected to run during peak load levels into table 6. Refer to table 1 for typical motor load sizes and electrical requirements.
- Enter kW for all non-motor loads expected to run during peak load levels into table 7. Refer to table 2 for typical residential loads and rules of thumb.
- Add the running motor load kW, non-motor load kW, and the starting kW of the largest motor load.

Motor load running total (minus largest motor): _____ kW
(ref. table 6)

Non-motor load total: (ref. table 7) _____ kW

Starting load from largest cycling motor: _____ kW
(ref. table 6)

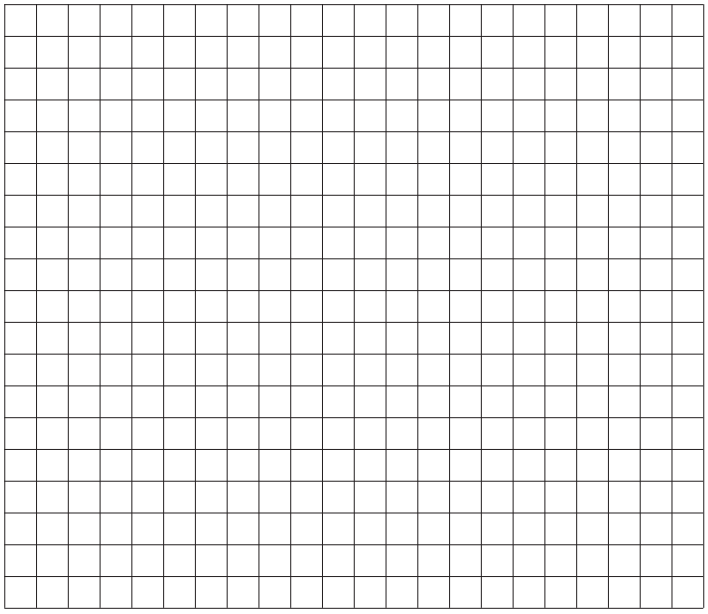
Total electrical loads: = _____ kW

Select generator: Commercial (add 20 to 25% to total kW)
Residential (add 10 to 20% to total kW)

- Confirm that voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see table #3).
- Confirm UPS compatibility (see page 6).

System Capacity – Load Calculation
If the local municipality or state you are in has adopted the 2008 NEC Code, you may be required to use this step. Article 702 of the 2008 NEC includes a new requirement for sizing (702.5B). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the NEC. The system capacity estimating sheet will guide you through this process.

Project Layout



Ball Park Estimates (Do not use for final sizing)

Estimate based on 60% service size: (commercial)

240 Volts, 1 Ø: _____ Amps x .15 = _____ kW
208 Volts, 3 Ø: _____ Amps x .22 = _____ kW
240 Volts, 3 Ø: _____ Amps x .25 = _____ kW
480 Volts, 3 Ø: _____ Amps x .50 = _____ kW

Estimate based on 40% service size: (residential)

240 Volts, 1 Ø: _____ Amps x .10 = _____ kW
208 Volts, 3 Ø: _____ Amps x .15 = _____ kW
240 Volts, 3 Ø: _____ Amps x .17 = _____ kW
480 Volts, 3 Ø: _____ Amps x .34 = _____ kW

Estimate based on square footage

Fast food, convenience stores, restaurants, grocery stores: kW = 50 kW + 10 watts/sq. ft.

Other commercial applications: kW = 30 kW + 5 watts/sq. ft.

Square footage = _____ Estimated kW = _____

Amps to kW Rule of Thumb (assumes .8 pf)

For 480 volt systems: Amps = kW x 1.5
For 208 volt systems: Amps = kW x 3.5
For 240 volt 3 Ø systems: Amps = kW x 3
For 240 volt 1 Ø systems: Amps = kW x 4

System Capacity – Load Calculator

Directions for Nec 2008, Article 220, Part Iv	
220.80 Optional Feeder and Service Load Calculations (RESIDENTIAL)	**NEC Reference**
Section Can Be Used For Dwelling Units	**220.82 (A)**
• Served by a single feeder conductor (generator) • 120/240 volt or 208Y/120 volt service • Ampacity of 100 amps or greater	
The calcultated load will be the result of adding • 220.82 (B) General Loads, and	220.82 (B)
• 220.82 (C) Heating and Air-Conditioning Load	220.82 (C)
• Calculated neutral load determined by 220.61. (Additional 70% demand factor can be taken for cooking appliances and dryers when tables 220.54 and/or 220.55 are used)	
General Loads	**220.82 (B)**
General Lighting and General-Use Receptacles • Calculate at 3 VA per square foot	220.82 (B) (1)
• Use exterior dimensions of the home to calculate square footage – do not include open porches, garages, or unused or unfinished spaces not adaptable for future use.	
• Add 20-amp small appliance & laundry circuits @ 1500 VA each	220.82 (B) (2)
Calculate the following loads at 100% of nameplate rating • Appliances fastened in place, permanently connected or located on a specific circuit	220.82 (B) (3) 220.82 (B) (3) a
• Ranges, wall-mounted ovens, counter-mounted cooking units (Tables 220.54 & 220.55)	220.82 (B) (3) b
• Clothes dryers not connected to the laundry branch circuit	220.82 (B) (3) c
• Water heaters	220.82 (B) (3) d
• Permanently connected motors not included in Heat & Air-Conditioning Load section	220.82 (B) (4)
Heating & Air-Conditioning Loads	**220.82 (C)**
Include the largest of the following six selections (kVA load) in calculation Air Conditioning and Cooling • 100% of nameplate rating	220.82 (C) (1)
Heat Pumps Without Supplemental Electric Heating • 100% of nameplate rating	220.82 (C) (2) 220.82 (C) (3)
Heat Pumps With Supplemental Electric Heating • 100% of nameplate rating of the heat pump compressor*	
• 65% of nameplate rating of supplemental electric heating equipment	
• If compressor & supplemental heat cannot run at the same time do not include the compressor	
Electric Space Heating • Less than 4 separately controlled units @ 65% of nameplate rating	220.82 (C) (4)
• 4 or more separately controlled units @ 40% of nameplate rating	220.82 (C) (5)
• 40% of nameplate rating if 4 or more separately controlled units	
Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating • 100% of nameplate rating	220.82 (C) (6)
• Systems of this type cannot be calculated under any other section of 220.82 (C).	

Load Calculations	
General Lighting Load • Small Appliance & Laundry Circuits	3 VA x ft² **+** 1500 VA per circuit
• General Appliances & Motors (100% rated load)	**+** Total general appliances
• Sum of all General Loads = Total General Load (VA)	Total general load (VA)
Apply Demand Factors • First 10 kVA @ 100%	**=** 10,000 VA
• Remainder of General Loads @ 40%	(Total VA - 10,000) x .40
• HEAT / A-C LOAD @ 100%	**=** Calculated General Load (VA) Largest Heat or A-C Load (VA)
	= TOTAL CALCULATED LOAD

Converting VA TO kW (Single-phase applications with 1.0 power factor only) 1 kVA = 1 kW

Worksheet — NEC 2008, 220 Part IV					
Contractor		Email			
Phone		Fax			
Job Name					
Date	Location				
Voltage (Circle)	240V -1Ø				
Fuel		NG	LPV		
Elec. Service	100 Amp	200 Amp	400 Amp	Other	
NET SQUARE FOOTAGE					

General Loads	**Qty**	**Rating (Load)**	**Factor**	**Loads (VA)**	**Loads (kW) (VA ÷ 1,000)**
General Lighting and General Use Receptacles		3 VA/ft²	100%		
Branch Circuits (1500 VA/ft²)					
Small Appliance Circuits (20 Amp)		1500	100%		
Laundry Circuits		1500	100%		
Fixed Appliances		Full Current Rating			
Well			100%		
Sump Pump			100%		
Freezer			100%		
Microwave (Not counter-top model)			100%		
Disposal			100%		
Dishwasher			100%		
Range (See Table 220.55 for multiple cooking appliances)			100%		
Wall-Mounted Oven			100%		
Counter-Mounted Cooking Surface			100%		
Water Heater			100%		
Clothes Dryer			100%		
Garage Door Opener			100%		
Septic Grinder			100%		
Other (list)			100%		
			100%		
			100%		
			100%		
			100%		
			100%		
			100%		
			100%		
			100%		
			100%		
TOTAL GENERAL LOADS				VA	kW

Heat / A-C Load					
A-C / Cooling Equipment			100%		
Heat Pump • Compressor (if not included as A-C) • Supplemental Electric Heat			 100% 65%		
Electric Space Heating • Less than 4 separately controlled units • 4 or more separately controlled units			 65% 40%		
System With Continuous Nameplate Load			100%		
Largest Heat / A-C Load (VA) VA kW					

General Loads					
1st 10 kW of General Loads 100% kW			100%	kw	
Remaining General Loads (kW) 40% kW			40%	kw	
CALCULATED GENERAL LOAD (kW) kW					kw
LARGEST HEAT / A-C LOAD 100% kW kW					kw
TOTAL CALCULATED LOAD (Net General Loads + Heat/A-C Load)					kw

Typical Single Phase Generator/Transfer Switch Combinations

Air Cooled Generators		Liquid Cooled Generators	
kW	**Transfer Switch**	**kW**	**Transfer Switch**
8	EGS50L12 EGS50L12R	22	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE
10	EGS50L12 EGS50L12R EGS100 EGS100SE EGS100L24R	25	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE
14	EGS100 EGS100SE EGS100L24R	27	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE EGS400NSE
17	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE	30	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE EGS400NSE
20	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE	36	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE EGS400NSE
		45	EGS100 EGS100SE EGS100L24R EGS200 EGS200SE EGS400NSE
		48	EGS200 EGS200SE EGS400NSE
		60	EGS200 EGS200SE EGS400NSE
		70-150	ATC, ATV and ATH switches

NEC (700, 701, 702) Comparison

NEC Comparison Table to be used as a general guideline in determining the proper generator for specific applications. Refer to architectural documents for final selection.

	Article 700 Emergency	**Article 701 Standby**	**Article 702 Optional Standby**
Scope	Legally required life safety	Legally required critical support (fire fighting, health hazards, etc)	Protect property & facilities
Equipment Approval	For Emergency / (UL2200)	For Intended Use / (UL2200)	For Intended Use / (UL2200) / Not in 2008
Testing			
Witness Testing (on-sight)	At install & periodically	At install	None
Periodic Testing	Yes	Yes	None
Battery Maintenance	Yes	Yes	None
Maintenance Records	Yes	Yes	None
Load Testing	Yes	Yes	None
Capacity	All Loads	All loads intended to operate at one time	All loads intended to operate at one time / Not in 2008
Other Standby Loads Allowed	Yes with load shedding	Yes with load shedding	2008 – Yes with load shedding
Peak Shaving Allowed	Yes ??	Yes	Yes
Transfer Switch			
Automatic	Yes	Yes	No
Equipment Approval	For Emergency / (UL1008)	For Standby / (UL1008)	For Intended Use / (UL1008)
Means to Permitt Bypass	Yes	No	No
Elect. Operated - Mech. Held	Yes	No	No
Other loads	No	Yes with load shedding	N/A
Max. Fault Current Capable	Yes	Yes	Yes
Signals (Audible & Visual)			
Derangement	Yes / Standard common alarm	Yes / Standard common alarm	Yes / Standard common alarm
Carrying Load	Yes / Displayed at ATS	Yes / Displayed at ATS	Yes / Displayed at ATS
Battery Charger Failed	Yes	Yes	No
Ground Fault Indication	Yes (480V & 1000A)	No	No
NFPA 110 Signaling	Yes / Optional annunciator	Yes / Optional annunciator	No
Signs			
At service	Yes / Type & location	Yes / Type & location	Yes / Type & location
At neutral to ground bonding	Yes (if remote)	Yes (if remote)	Yes (if remote)
Wiring kept independent	Yes	No	No
Fire protection (ref 700-9d)	Yes (1000 persons or 75' building)	No	No
Maximum power outage	10 sec	60 sec	N/A
Retransfer delay	15 min setting	15 min setting	No
Automatic starting	Yes	Yes	No
On-site fuel requirements	2 hours (see NFPA 110)	2 hours	None
Battery charger	Yes	Yes	No
Ground Fault	Indication Only	No	No

Electrical Formulas

To Find	Known Values	1-Phase	3-Phase
KILOWATTS (kW)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73 \times PF}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73}{1000}$
AMPERES	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$	$\frac{kW \times 1000}{E \times 1.73 \times PF}$
WATTS	Volts, Amps, Power Factor	Volts x Amps	E x I x 1.73 x PF
NO. OF ROTOR POLES	Frequency, RPM	$\frac{2 \times 60 \times Frequency}{RPM}$	$\frac{2 \times 60 \times frequency}{RPM}$
FREQUENCY	RPM, No. of Rotor Poles	$\frac{RPM \times Poles}{2 \times 60}$	$\frac{RPM \times Poles}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times Frequency}{Rotor\ Poles}$	$\frac{2 \times 60 \times Frequency}{Rotor\ Poles}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{Efficiency}$	$\frac{HP \times 0.746}{Efficiency}$
RESISTANCE	Volts, Amperes	$\frac{E}{I}$	$\frac{E}{I}$
VOLTS	Ohms, Amperes	I x R	I x R
AMPERES	Ohms, Volts	$\frac{E}{R}$	$\frac{E}{R}$

- E = VOLTS
- I = AMPERES
- R = RESISTANCE (OHMS)
- PF = POWER FACTOR

Weights and Measures

U.S. Weights and Measures

Linear Measurements

		1 Inch	=	2.540 Centimeters
12 Inches	=	1 Foot	=	3.048 Decimeters
3 Feet	=	1 Yard	=	9.144 Decimeters
5.5 Yards	=	1 Rod	=	5.029 Meters
40 Rods	=	1 Furlong	=	2.018 Hectometers
8 Furlongs	=	1 Mile	=	1.609 Kilometers

Mile Measurements

1 Statute	=	5,280 Feet
1 Scots	=	5,952 Feet
1 Irish	=	6,720 Feet
1 Russian	=	3,504 Feet
1 Italian	=	4,401 Feet
1 Spanish	=	15,084 Feet

Other Linear Measurements

1 Hand	=	4 Inches		1 Link	=	7.92 Inches
1 Span	=	9 Inches		1 Fathom	=	6 Feet
1 Chain	=	22 Yards		1 Furlong	=	10 Chains
				1 Cable	=	608 Feet

Square Measurements

144 Square inches	=	1 Square foot
9 Square feet	=	1 Square yard
$30^{1/4}$ Yards	=	1 Square rod
40 Rods	=	1 Rood
4 Roods	=	1 Acre
640 Acres	=	1 Square mile
1 Square mile	=	1 Section
36 Sections	=	1 Township

Cubic or Solid Measure

1 Cu. foot	=	1728 Cu. inches
1 Cu. yard	=	27 Cu. feet
1 Cu. foot	=	7.48 Gallons
1 Gallon (Water)	=	8.34 Lbs.
1 Gallon (U.S.)	=	231 Cu. inches of water
1 Gallon (Imperial)	=	$277^{1/4}$ Cu. inches or water

Metric System

Cube Measure (The unit is the meter = 39.37 Inches)

1 Cu. Centimeter	=	1000 Cu. Millimeters	=	0.06102 Cu. Inches
1 Cu. Decimeter	=	1000 Cu. Centimeters	=	61.02374 Cu. Inches
1 Cu. Meter	=	1000 Cu. Decimeters	=	35.31467 Cu. Feet
	=	1 Steer	=	1.30795 Cu. Yards
1 Cu. Centimeter (Water)	=	1 Gram		
1000 Cu. Centimeter (Water)	=	1 Liter	=	1 Kilogram
1 Cu. Meter (1000 Liters)	=	1 Metric ton		

Measures of Weight (The unit is the gram = 0.035274 Ounces)

1 Milligram	=	0.015432 Grains		
1 Centigram	=	10 Milligrams	=	0.15432 Grains
1 Decigram	=	10 Centigrams	=	1.5432 Grains
1 Gram	=	10 Decigrams	=	15.4323 Grains
1 Dekagram	=	10 Grains	=	5.6438 Drams
1 Hectogram	=	10 Dekagrams	=	3.5274 Ounces
1 Kilogram	=	10 Hectograms	=	2.2046223 Pounds
1 Myriagram	=	10 Kilograms	=	22.046223 Pounds
1 Quintal	=	10 Myriagrams	=	1.986412 Cwt.
1 Metric Ton	=	10 Quintal	=	2,2045.622 Pounds
1 Gram	=	.056438 Drams		
1 Dram	=	1.77186 Grams 27.3438 Grains		
1 Metric Ton	=	2,204.6223 Pounds		

Measures of Capacity (The unit is the liter = 1.0567 Liquid quarts)

1 Centiliter	=	10 Milliliters	=	0.338 Fluid ounces
1 Deciliter	=	10 Centiliters	=	3.38 Fluid ounces
1 Liter	=	10 Deciliters	=	33.8 Fluid ounces
1 Dekaliter	=	10 Liters	=	0.284 Bushel
1 Hectoliter	=	10 Dekaliters	=	2.84 Bushels
1 Kiloliter	=	10 Hectoliters	=	264.2 Gallons

Note: $\frac{\text{Kilometers}}{8} \times 5 = \text{Miles}$ or $\frac{\text{Miles}}{5} \times 8 = \text{Kilometers}$

Weights and Measures

Metric System						
Prefixes						
A. Mega	=	1,000,000		E. Deci	=	0.1
B. Kilo	=	1,000		F. Centi	=	0.01
C. Hecto	=	100		G. Milli	=	0.001
D. Deka	=	10		H. Micro	=	0.000001

Linear Measurement (The unit is the meter = 39.37 Inches)

1 Centimeter	=	10 Millimeters	=	0.3937011 Inches
1 Decimeter	=	10 Centimeters	=	3.9370113 Inches
1 Meter	=	10 Decimeters	=	1.0936143 Yards 3.2808429 Feet
1 Dekameter	=	10 Meters	=	10.936143 Yards
1 Hectometer	=	10 Dekameters	=	109.36143 Yards
1 Kilometer	=	10 Hectometers	=	0.62137 Mile
1 Myriameter	=	10,000 Meters		

Square Measurement (The unit is the square meter = 1549.9969 Square Inches)

1 Sq. Centimeter	=	100 Sq. Millimeters	=	0.1550 Sq. Inches
1 Sq. Decimeter	=	100 Sq. Centimeters	=	15.550 Sq. Inches
1 Sq. Meter	=	100 Sq. Decimeters	=	10.7639 Sq. Feet
1 Sq. Dekameter	=	100 Sq. Meters	=	119.60 Sq. Yards
1 Sq. Hectometer	=	100 Sq. Dekameters		
1 Sq. Kilometer	=	100 Sq. Hectometers		
(The unit is the "Are" = 100 Square Meters)				
1 Centiare	=	10 Milliares	=	10.7643 Sq. Feet
1 Deciare	=	10 Centiares	=	11.96033 Sq. Yards
1 Are	=	10 Deciares	=	119.6033 Sq. Yards
1 Dekare	=	10 Ares	=	0.247110 Acres
1 Hektare	=	10 Dekares	=	2.471098 Acres
1 Sq. Kilometer	=	100 Hektares	=	0.38611 Sq. Mile

Cubic Measure (The unit is the "Stere" = 61,025.38659 Cubic Inches)

1 Decistere	=	10 Centisteres	=	3.531562 Cubic Inches
1 Stere	=	10 Decisteres	=	1.307986 Cubic Yards
1 Dekastere	=	10 Steres	=	13.07986 Cubic Yards

Metric Designator and Trade Sizes											
Metric Designator											
12	16	27	35	41	53	63	78	91	103	129	155
Trade Size											
3/8	1/2	1	$1^{1/4}$	$1^{1/2}$	2	$2^{1/2}$	3	$3^{1/2}$	4	5	6

U.S. Weights & Measures / Metric Equivalent Chart

	In.	Ft.	Yd.	Mile	Mm	Cm	M	Km
1 inch =	1	.0833	.0278	1.578×10^{-5}	25.4	2.54	.0254	2.54×10^{-5}
1 Foot =	12	1	.333	1.894×10^{-4}	304.8	30.48	.3048	3.048×10^{-4}
1 Yard =	36	3	1	5.6818×10^{-4}	914.4	91.44	.9144	9.144×10^{-4}
1 Mile =	63,360	5,280	1,760	1	1,609,344	160,934.4	1,690.344	1.609344
1 Mm =	.03937	.0032808	1.0936×10^{-3}	6.2137×10^{-7}	1	0.1	0.001	0.000001
1 Cm =	.3937	.0328084	.0109361	6.2137×10^{-6}	10	1	0.01	0.00001
1 M =	39.37	3.28084	1.09361	6.2137×10^{-4}	1000	100	1	0.001
1 Km =	39,370	3,280.84	1,093.61	0.62137	1,000,000	100,000	1,000	1

Scientific Notation:
A way of expressing very large or very small numbers in a more compact format. Any number can be expressed as a number between 1 & 10, multiplied by a power of 10 (which indicates the correct position of the decimal point in the original number). Numbers greater than 10 have positive powers of 10, and numbers less than 1 have negative powers of 10.

Useful Conversions / Equivalents	
1 BTU	Raises 1 Lb. of water 1º F
1 Gram Calorie	Raises 1 Gram of water 1º C
1 Circular Mil	= 0.7854 Sq. Mil
1 Sq. Mil	= 1.27 Cir. Mils
1 Mil	= 0.001

Notes

Notes

Generator and transfer switch products are supported by an unparalleled service network and sales force.

- 24 hour support 7 days a week.
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Printed in USA
Publication No. TD00405018E
August 2009