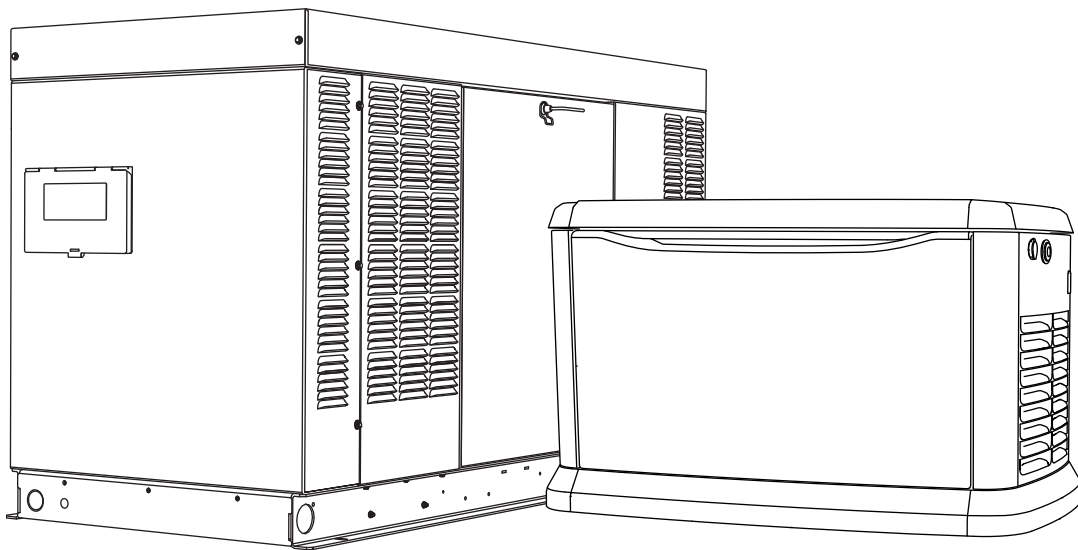


## *Generator Sizing Guide*



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## **IMPORTANT NOTICE**

This booklet is designed to familiarize estimators and installers with correct sizing guidelines for residential and commercial generators. The information is not comprehensive, nor does it replace or supersede 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**

This booklet contains electrical load information, plus an outline of generator surge capability, fuel pipe sizing, liquid propane (LP) tank sizing, and UPS / generator compatibility. The worksheet pages can be removed from the book and photocopied to create additional on-site estimating sheets for use with individual jobs.

## **SAFETY INFORMATION**

Correct generator sizing is crucial to the success of any installation and requires a working knowledge of electricity and its characteristics, as well as the varying requirements of the electrical equipment comprising the load. When analyzing electrical loads, see the manufacturer's nameplate on each major appliance or piece of equipment to determine starting and running requirements in terms of watts, amps, and voltage. When choosing generator output for commercial or industrial applications, select a rating approximately 20–25% higher than peak load (for example, if the load is about 40 kilowatts, select a 50 kW unit). 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.

For safety reasons, the manufacturer recommends the standby power system be installed, serviced, and repaired by an Independent Authorized Service Dealer (IASD) or a competent, qualified electrician or installation technician who is familiar with applicable codes, standards, and regulations.

Strictly 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 which may dictate requirements regarding unit placement (setback from building and/or lot line), electrical wiring, gas piping, fuel storage (for liquid propane or diesel tanks), sound, and exhaust emissions.

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### Carbon Monoxide Detectors

See [Figure 3-1](#). CO detectors (K) must be installed and used to monitor for CO and to warn individuals about the presence of CO. CO detectors must be installed and tested in accordance with the CO detector manufacturer's instructions and warnings. Contact local building inspection department for any applicable requirements concerning CO detectors. See NFPA 72, National Fire Alarm and Signaling Code, and Section R315 in the ICC International Residential Code for more information.

**IMPORTANT NOTE: Common smoke alarms do NOT detect CO gas. Do not rely on smoke alarms to protect residents or animals from CO. The only way to detect CO is to have functioning CO alarms.**

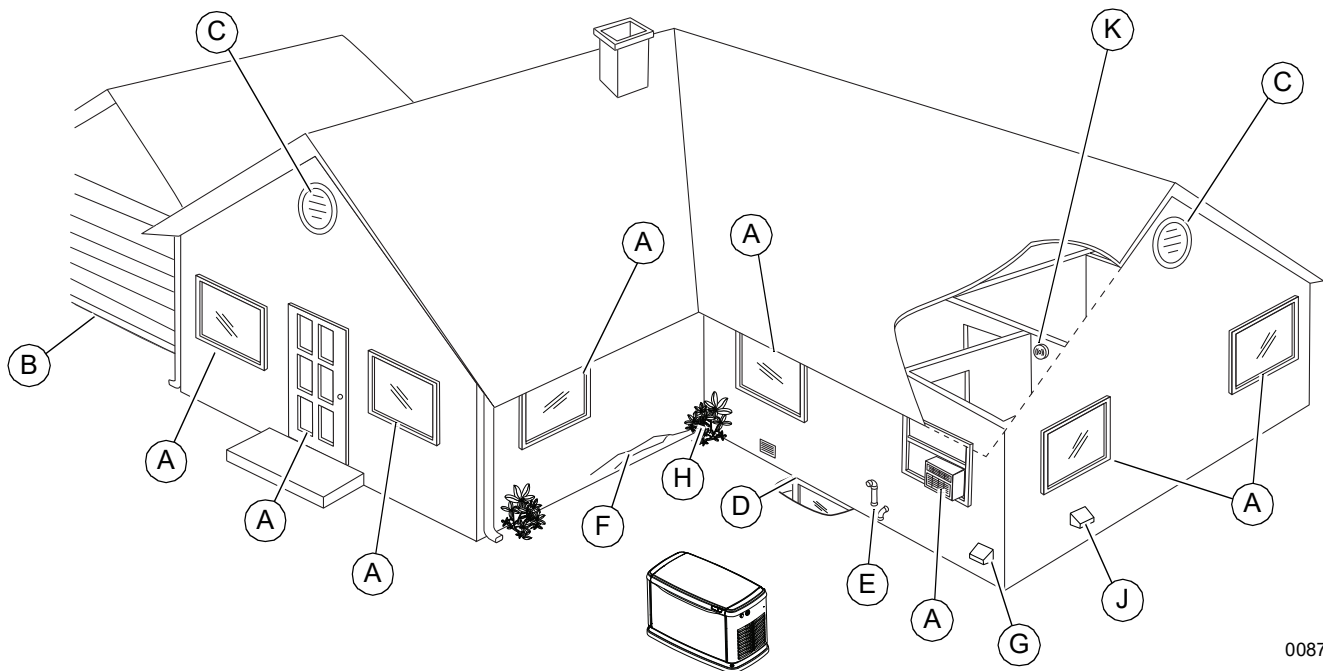
### Potential CO Entry Points

See [Figure 3-1](#). Generator exhaust can enter a structure through large openings, such as windows and doors. However, exhaust and CO can also seep into the structure through smaller, less obvious openings.

### Protect the Structure

Verify structure itself is correctly caulked and sealed to prevent air from leaking in or out. Voids, cracks, or openings around windows, doors, soffits, pipes, and vents can allow exhaust gas to be drawn into the structure.

Some examples of potential entry points are described and included in, but not limited to, the accompanying table.



**Figure 3-1. Carbon Monoxide—Potential Entry Points**

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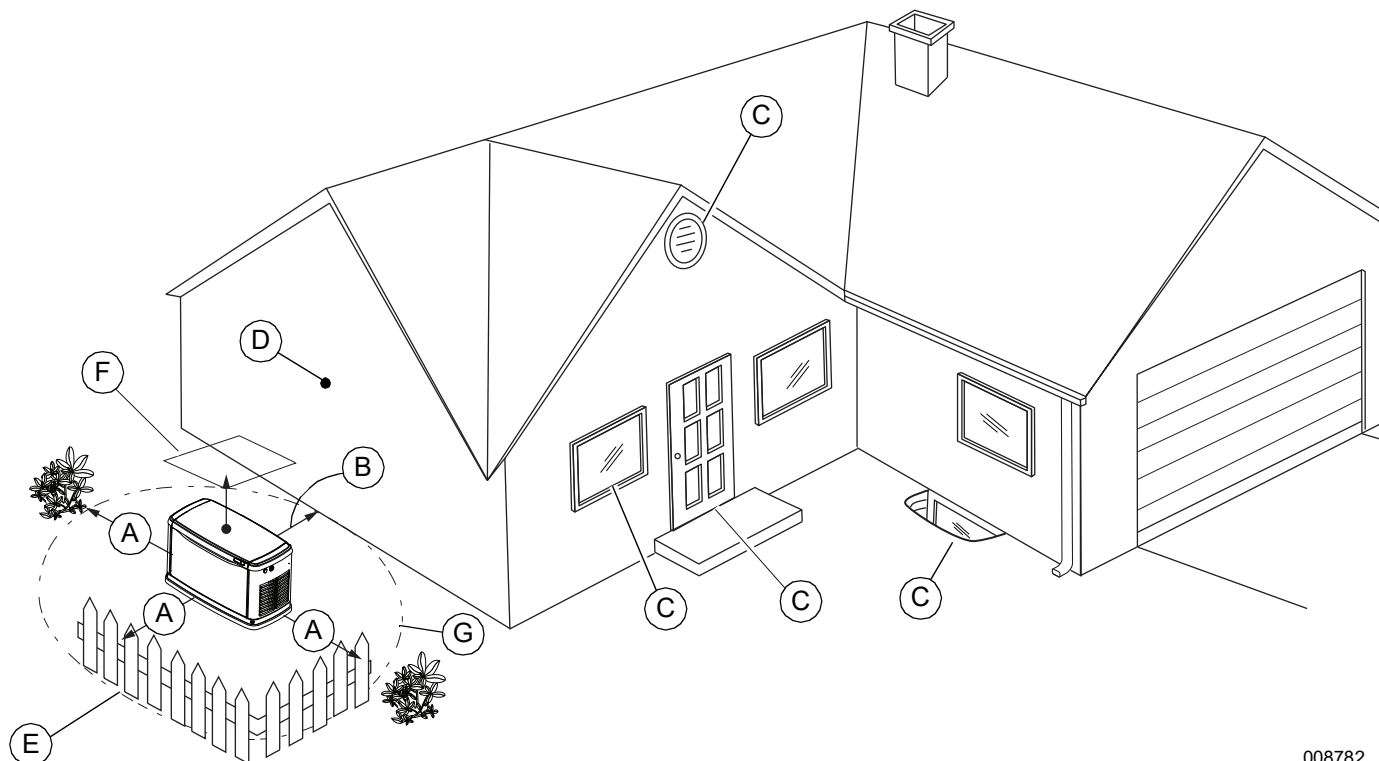
| ID | Entry Point                   | Description / Comments                                                                                                                                                                                                                                                       |
|----|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A  | Windows and doors             | Architectural details which can be (or are) opened to admit fresh air into the structure.                                                                                                                                                                                    |
| B  | Garage door                   | CO can leak into garage if door is open, or does not seal correctly when closed.                                                                                                                                                                                             |
| C  | Attic vent                    | Attic vents, ridge vents, crawl space vents, and soffit vents can all admit generator exhaust.                                                                                                                                                                               |
| D  | Basement windows              | Windows or hatches allowing ventilation to or from lower level of a structure.                                                                                                                                                                                               |
| E  | Furnace intake / exhaust vent | Air intake and exhaust pipes for furnace.                                                                                                                                                                                                                                    |
| F  | Wall cracks                   | Includes (but not limited to) cracks in wall, foundation, mortar, or air gaps around doors, windows, and pipes.                                                                                                                                                              |
| G  | Dryer vent                    | Exhaust duct for clothes dryer.                                                                                                                                                                                                                                              |
| H  | Airflow restrictions          | Structural corners and locations with heavy vegetation restrict airflow. Exhaust gases can collect in such areas.                                                                                                                                                            |
| J  | Make up air system            | <b>IMPORTANT NOTE: Mechanical and gravity outdoor air intake openings for HVAC supply air systems shall be located not less than 10 feet (3048mm) horizontally from the generator enclosure. See Section 401 in the ICC Mechanical Code for any additional requirements.</b> |
| K  | CO detector                   | Semi-permanently mounted device that detects carbon monoxide within the living area of the structure.                                                                                                                                                                        |

## Fire Prevention

The generator must be installed at a safe distance away from combustible materials. Engine, alternator, and exhaust system components become very hot during operation. Fire risk increases if unit is not correctly ventilated, is not correctly maintained, operates too close to combustible materials, or if fuel leaks exist. Also, accumulations of flammable debris within or outside the generator enclosure may ignite.

## Distance Requirements

See [Figure 3-2](#). Minimum clearances must be maintained around the generator enclosure. These clearances are primarily for fire prevention, but also to provide sufficient room for removing front and end panels for maintenance purposes.



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**Figure 3-2. Generator Distance Requirements**

| ID | Description                  | Definition                                                                                                                                                                                                                                           |
|----|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A  | Front and end clearance      | Minimum clearance from the front and ends of generator must be 3 ft (0.91 m). This includes shrubs, bushes, and trees.                                                                                                                               |
| B  | Rear clearance               | Fuel and electrical connections are made here. 18 in (457 mm) minimum clearance per SwRI testing, labeling, and listing, unless state or local codes dictate otherwise.                                                                              |
| C  | Windows, vents, and openings | No operable windows, doors, vents, window wells, or openings in the wall are permitted near any point of the generator set. See unit installation manual for more information.                                                                       |
| D  | Existing wall                | The generator should not be placed closer than 18 in (457 mm) from existing walls.                                                                                                                                                                   |
| E  | Removable fence              | A removable barrier (non-permanent; without footings) installed as a visual surround. Removable fence panels for servicing cannot be placed less than 3 ft (0.91 m) in front of the generator.                                                       |
| F  | Overhead clearance           | 5 ft (1.52 m) minimum distance from any structure, overhang, or projections from wall.                                                                                                                                                               |
| G  | Maintenance and servicing    | Maneuvering space around generator set for performing routine maintenance tasks such as battery replacement and engine service. Do not attempt to conceal generator set with shrubs, bushes, or plants. See NEC Article 110.26 for more information. |

**Table 1. Motor Load Reference AC & Heat Pumps**

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

\* For multiple motor configurations, sequence starting is assumed.

Air Conditioning  
1 hp per 1 ton  
1 ton = 12,000 BTUs

**Table 2. Motor Load Reference General Residential**

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

**Table 3. Non-Motor Load Reference—Residential**

| Description                                               | kW   | Amps @ 120V 1Ø | Amps @ 240V 1Ø |
|-----------------------------------------------------------|------|----------------|----------------|
| Electric heat per 1000 ft <sup>2</sup>                    | 12   | N/A            | 50             |
| Heat pump elements per 1000 ft <sup>2</sup>               | 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             |
| Electric hot water                                        | 4.5  | N/A            | 19             |
| General lighting and receptacles per 1000 ft <sup>2</sup> | 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            |
| Toaster                                                   | 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            |

\*Always check data plate for actual running amps.

**Table 4. Non-Motor Load Reference—Commercial**

See equipment data plate and/or billing history for commercial details.

**Table 5. Surge Capability—Air-cooled Generators**

| Size (kW)       | RPM  | Rated Output (Running Amps) LP / NG |         |         |         | Maximum Surge Capability |         |         |         |
|-----------------|------|-------------------------------------|---------|---------|---------|--------------------------|---------|---------|---------|
|                 |      | 240V 1Ø                             | 208V 3Ø | 240V 3Ø | 480V 3Ø | 240V 1Ø                  | 208V 3Ø | 240V 3Ø | 480V 3Ø |
| 7.5             | 3600 | 31/25                               | N/A     | N/A     | N/A     | 62                       | N/A     | N/A     | N/A     |
| 10              | 3600 | 42/38                               | N/A     | N/A     | N/A     | 70                       | N/A     | N/A     | N/A     |
| 13              | 3600 | 54/54                               | N/A     | N/A     | N/A     | 95                       | N/A     | N/A     | N/A     |
| 15 ECO          | 3600 | 63/63                               | N/A     | N/A     | N/A     | 185                      | N/A     | N/A     | N/A     |
| 16              | 3600 | 66/66                               | N/A     | N/A     | N/A     | 130                      | N/A     | N/A     | N/A     |
| 20              | 3600 | 83/75                               | N/A     | N/A     | N/A     | 185                      | N/A     | N/A     | N/A     |
| 20 kW - 3 Phase | 3600 | N/A                                 | 69/59   | N/A     | N/A     | N/A                      | 112     | N/A     | N/A     |
| 22              | 3600 | 92/81                               | N/A     | N/A     | N/A     | 210                      | N/A     | N/A     | N/A     |
| 24              | 3600 | 100/89                              | N/A     | N/A     | N/A     | 220                      | N/A     | N/A     | N/A     |

Maximum power decreases approximately 3.5% for each 1,000 ft (304.8 m) above sea level, and will decrease approximately 1% for each 10 °F (6 °C) above 60 °F (16 °C).

**Table 6. Surge Capability—Liquid-Cooled Generators**

| Size (kW) | RPM  | Rated Output (Running Amps) LP / NG |         |         |                 | Maximum Surge Capability |         |         |         |
|-----------|------|-------------------------------------|---------|---------|-----------------|--------------------------|---------|---------|---------|
|           |      | 240V 1Ø                             | 208V 3Ø | 240V 3Ø | 480V 3Ø         | 240V 1Ø                  | 208V 3Ø | 240V 3Ø | 480V 3Ø |
| 22        | 1800 | 92/92                               | 76/76   | 66/66   | N/A             | 135                      | 92      | 80      | N/A     |
| 25        | 3600 | 104/104                             | 87/87   | 75/75   | N/A             | 170                      | 130     | 112     | N/A     |
| 27        | 1800 | 113/104                             | 94/87   | 81/75   | N/A             | 170                      | 120     | 103     | N/A     |
| 30        | 3600 | 125/125                             | 104/104 | 90/90   | N/A             | 180                      | 155     | 134     | N/A     |
| 32        | 1800 | 133/133                             | 111/111 | 96/96   | 48/48           | 180                      | 210     | 182     | 87      |
| 36        | 3600 | 150/146                             | 125/121 | 108/105 | 54/53           | 240                      | 130     | 115     | 60      |
| 38        | 1800 | 158/158                             | 132/132 | 114/114 | 57/57           | 180                      | 210     | 182     | 87      |
| 45        | 3600 | 188/188                             | 156/156 | 135/135 | 68/68           | 240                      | 130     | 115     | 60      |
| 48        | 1800 | 300/300                             | 242/242 | 189/189 | 122.8/122.8     | 300                      | 242     | 260     | 126     |
| 60        | 3600 | 320/320                             | 210/210 | 182/182 | 91/91           | 320                      | 210     | 182     | 91      |
| 70        | 1800 | 292/267                             | 242/232 | 210/201 | 105/101         | 356                      | 471     | 408     | 201     |
| 80        | 3600 | 600/600                             | 500/500 | 432/432 | Contact Factory | 435                      | 466     | 404     | 175     |
| 100       | 2300 | 417/371                             | 347/326 | 300/282 | 150/141         | 413                      | 452     | 392     | 261     |
| 130       | 2970 | 542/488                             | 451/423 | 390/367 | 195/183         | 648                      | 885     | 767     | 390     |
| 150       | 3600 | 625/625                             | 520/493 | 451/427 | 225/214         | 1,214                    | 1,334   | 1,156   | 624     |

Temperature Deration: 1.65% for every 10 °F above 77 °F or 3% for every 10 °C above 25 °C.

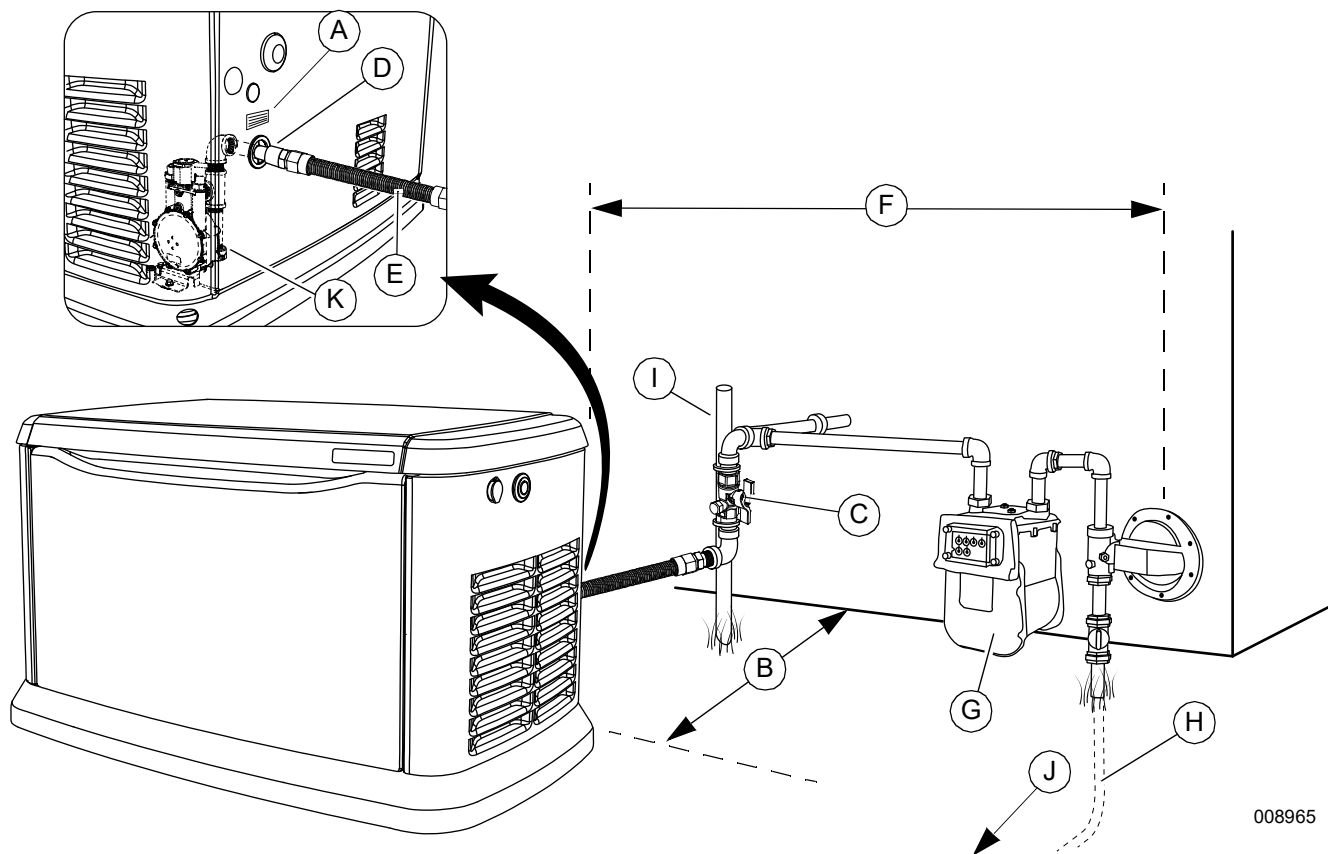
Altitude Deration (22, 25, 27, 30, 45, 48, 70, 100, 130 and 150): 3% for every 1,000 ft above 600 ft or 1% for every 100 m above 183 m.

Altitude Deration (32, 36, 38, 60, and 80 kW): 3% for every 1,000 ft above 3,000 ft or 1% for every 100 m above 915 m.

**Table 7. Surge Capability—Protector Series Generators (Diesel)**

| Size (kW) | Rated Output (Running Amps) |         |         |         | Maximum Surge Capability (LR Amps @ 30% Voltage Dip) |         |         |         |
|-----------|-----------------------------|---------|---------|---------|------------------------------------------------------|---------|---------|---------|
|           | 240V 1Ø                     | 208V 3Ø | 240V 3Ø | 480V 3Ø | 240V 1Ø                                              | 208V 3Ø | 240V 3Ø | 480V 3Ø |
| 15        | 62                          | 52      | 45      | N/A     | 129                                                  | 90      | 78      | N/A     |
| 20        | 83                          | 69      | 60      | N/A     | 211                                                  | 143     | 124     | N/A     |
| 30        | 125                         | 104     | 90      | 45      | 168                                                  | 144     | 125     | 64      |
| 48/50     | 200                         | 173     | 150     | 75      | 189                                                  | 218     | 189     | 87      |

## Natural Gas Installation (Typical)



| NG Megajoules/h = m <sup>3</sup> /h X 37.26 |                                                                                                                                                                                   | BTU/h = ft <sup>3</sup> /h X 1000 |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| A                                           | Fuel data decal                                                                                                                                                                   |                                   |
| B                                           | Minimum distance from rear obstruction—see unit installation manual for distance requirements                                                                                     |                                   |
| C                                           | Manual fuel shutoff valve (pressure port optional)<br>Must be located no more than 6 ft (1.83 m) away from fuel inlet                                                             |                                   |
| D                                           | Pipe fittings (field supplied)                                                                                                                                                    |                                   |
| E                                           | Flexible fuel line                                                                                                                                                                |                                   |
| F                                           | Verify clearance with gas provider. Regulator should be a minimum of 5 ft (1.5 m) from generator. Local codes and regulator manufacturer may have further clearance requirements. |                                   |
| G                                           | Size gas meter for generator set operating at FULL load plus all appliance loads                                                                                                  |                                   |
| H                                           | For underground installations, verify piping system for code compliance                                                                                                           |                                   |
| I                                           | Reinforcing rod with clamps                                                                                                                                                       |                                   |
| J                                           | To gas main                                                                                                                                                                       |                                   |
| K                                           | Sediment trap                                                                                                                                                                     |                                   |

**Figure 3-3. Natural Gas Installation (typical)**

**Table 8. Fuel Pipe Sizing—Natural Gas**

| in WC / kPa         | kW        | Pipe Size<br>(in / mm) | Allowable Pipe Distances (ft / m) |           |             |             |             |             |              |
|---------------------|-----------|------------------------|-----------------------------------|-----------|-------------|-------------|-------------|-------------|--------------|
|                     |           |                        | 0.75 / 19                         | 1 / 25    | 1.25 / 32   | 1.5 / 38    | 2 / 51      | 2.5 / 63    | 3 / 76       |
| 3.5–7 / 0.871–1.74  | 7.5/10    |                        | 60 / 18.3                         | 200 / 61  | 750 / 228.6 |             |             |             |              |
|                     | 13/16     |                        | 10 / 3.1                          | 55 / 16.7 | 200 / 61    | 450 / 137.1 |             |             |              |
|                     | 15 ECO/20 |                        | 10 / 3.1                          | 35 / 10.7 | 140 / 42.6  | 300 / 91.4  |             |             |              |
|                     | 20-3Ph.   |                        | 10 / 3.1                          | 35 / 10.7 | 140 / 42.6  | 300 / 91.4  |             |             |              |
|                     | 22        |                        | 10 / 3.1                          | 30 / 9.1  | 115 / 35    | 250 / 76.2  |             |             |              |
|                     | 24        |                        | 10 / 3.1                          | 30 / 9.1  | 115 / 35    | 250 / 76.2  |             |             |              |
| 5–14 / 1.244–3.484  | 25 & 30   |                        |                                   | 10 / 3.1  | 60 / 18.2   | 125 / 38.1  | 450 / 137.1 |             |              |
|                     | 22 & 27   |                        |                                   | 20 / 6.1  | 100 / 30.4  | 200 / 61    | 700 / 213.3 |             |              |
|                     | 32        |                        |                                   | 20 / 6.1  | 100 / 30.4  | 200 / 61    | 700 / 213.3 |             |              |
|                     | 36        |                        |                                   |           | 30 / 9.1    | 60 / 18.3   | 220 / 67    |             |              |
|                     | 38        |                        |                                   | 10 / 3.1  | 70 / 21.3   | 150 / 45.7  | 500 / 152.4 |             |              |
|                     | 45        |                        |                                   |           | 10 / 3.1    | 60 / 18.3   | 200 / 61    | 450 / 137.1 |              |
|                     | 48        |                        |                                   |           | 10 / 3.1    | 60 / 18.3   | 200 / 61    | 450 / 137.1 |              |
|                     | 60        |                        |                                   |           | 20 / 6.1    | 40 / 12.2   | 150 / 45.7  | 350 / 106.6 | 1000 / 304.8 |
| 11–14 / 2.739–3.487 | 70        |                        |                                   |           | 10 / 3.1    | 30 / 9.1    | 100 / 30.4  | 200 / 61    | 700 / 213.3  |
|                     | 80        |                        |                                   |           | 10 / 3.1    | 20 / 6.1    | 75 / 22.8   | 170 / 51.8  | 475 / 144.7  |
|                     | 100       |                        |                                   |           | 10 / 3.1    | 20 / 6.1    | 75 / 22.8   | 170 / 51.8  | 475 / 144.7  |
|                     | 130       |                        |                                   |           |             | 10 / 3.1    | 40 / 12.2   | 90 / 27.4   | 250 / 76.2   |
|                     | 150       |                        |                                   |           |             | 10 / 3.1    | 30 / 9.1    | 70 / 21.3   | 200 / 61     |

**Table 9. Fuel Pipe Sizing Natural Gas—3.5–4.9 in water column**

| Pipe Size<br>(in / mm) | Allowable Pipe Distances (ft / m) |           |            |            |
|------------------------|-----------------------------------|-----------|------------|------------|
|                        | 0.75 / 19                         | 1 / 25    | 1.25 / 32  | 1.5 / 38   |
| 10 kW                  | 20 / 6.1                          | 60 / 18.3 | 175 / 53.3 |            |
| 13/16 kW               |                                   | 30 / 9.1  | 125 / 38.1 | 200 / 61   |
| 15 ECO kW              |                                   | 10 / 3.1  | 60 / 18.3  | 125 / 38.1 |
| 20/22 kW               |                                   | 10 / 3.1  | 60 / 18.3  | 125 / 38.1 |
| 20-3Ph. kW             |                                   | 10 / 3.1  | 60 / 18.3  | 125 / 38.1 |

### 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 in Hg = 13.61 in water column

1 in water column = 0.249 kPa

3.5–14 in water column = 0.872–3.487 kPa

### NOTE:

- Pipe sizing is based on 0.5 in water column pressure drop.
- Verify adequate service and meter sizing.
- Tables based on schedule 40 black pipe.

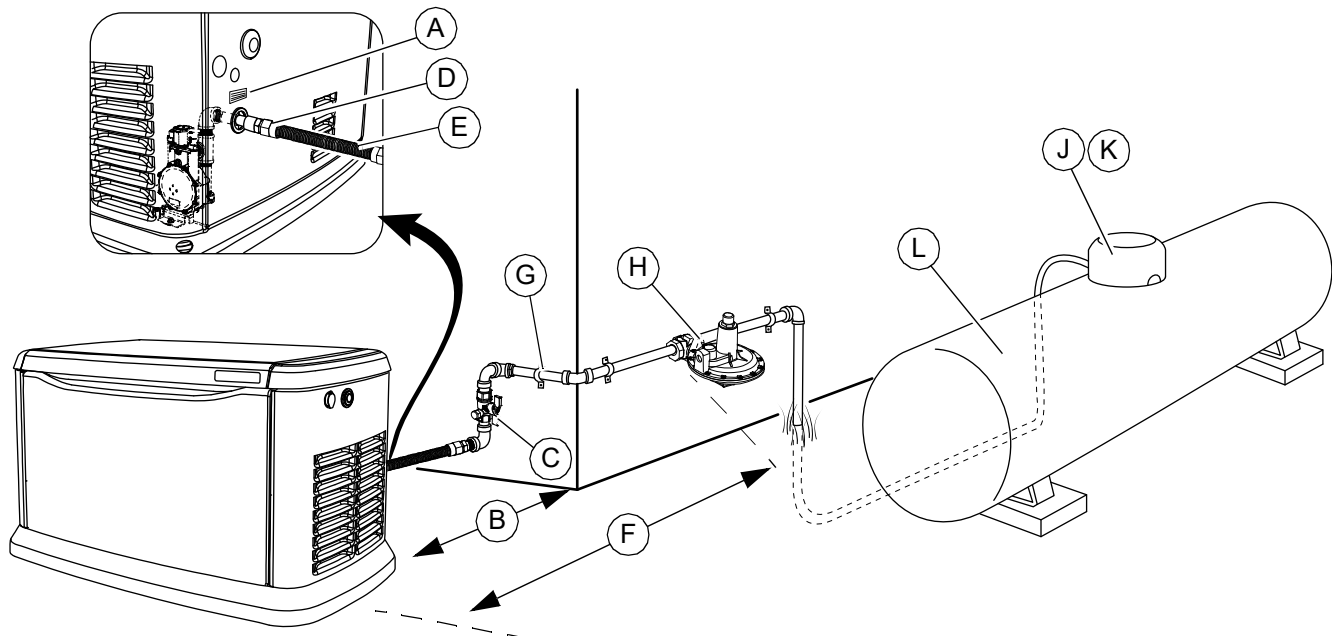
**NOTE:** Size fuel pipe according to sizing charts or local codes. When installing fuel piping other than Sch. 40 black pipe, see manufactures sizing charts and size that product to comply with the requirements outlined here-in.

**The piping system between the primary pressure regulator and generator must be correctly sized to provide fuel volume required at 100% load, while also staying within pressure range noted on unit specification sheet.**

**Table 10. Equivalent Straight Lengths in Ft / M of Sch. 40 Pipe Fittings and Valves**

| Pipe Size<br>(in / mm) | 45° Elbow   | 90° Elbow   | Tee Fitting | Fuel Shutoff |
|------------------------|-------------|-------------|-------------|--------------|
| 0.75 / 19              | 0.96 / 0.29 | 2.06 / 0.63 | 4.12 / 1.25 | 0.48 / 0.14  |
| 1 / 25                 | 1.22 / 0.37 | 2.62 / 0.80 | 5.24 / 1.60 | 0.61 / 0.18  |
| 1.25 / 32              | 1.61 / 0.49 | 3.45 / 1.0  | 6.9 / 2.10  | 0.81 / 0.25  |
| 1.5 / 38               | 1.88 / 0.57 | 4.02 / 1.22 | 8.04 / 2.45 | 0.94 / 0.29  |
| 2 / 51                 | 2.41 / 0.73 | 5.17 / 1.57 | 10.3 / 3.14 | 1.21 / 0.37  |
| 2.5 / 63               | 2.88 / 0.88 | 6.16 / 1.88 | 12.3 / 3.75 | 1.44 / 0.44  |
| 3 / 76                 | 3.58 / 1.10 | 12.6 / 3.84 | 15.3 / 4.66 | 1.79 / 0.55  |

## LP Gas Installation (Typical)



008966

| LPG Megajoules/h = m <sup>3</sup> /h X 93.15 |                                                                                                                                                                                                                                     | BTU/h = ft <sup>3</sup> /h X 2520 |  |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--|
| A                                            | Fuel data decal                                                                                                                                                                                                                     |                                   |  |
| B                                            | Minimum distance from rear obstruction—see unit installation manual for distance requirements                                                                                                                                       |                                   |  |
| C                                            | Manual fuel shutoff valve (pressure port optional)<br>Must be located no more than 6 ft (1.83 m) away from fuel inlet.                                                                                                              |                                   |  |
| D                                            | Pipe fittings (field supplied)                                                                                                                                                                                                      |                                   |  |
| E                                            | Flexible fuel line                                                                                                                                                                                                                  |                                   |  |
| F                                            | Verify minimum distance requirements for regulator vent according to local gas codes. Regulator should be a minimum of 5 ft (1.5 m) from generator. Local codes and regulator manufacturer may have further clearance requirements. |                                   |  |
| G                                            | Clamp                                                                                                                                                                                                                               |                                   |  |
| H                                            | Secondary fuel pressure regulator                                                                                                                                                                                                   |                                   |  |
| J                                            | Manual fuel shutoff valve                                                                                                                                                                                                           |                                   |  |
| K                                            | Primary fuel pressure regulator                                                                                                                                                                                                     |                                   |  |
| L                                            | Fuel tank—sized large enough to provide required MJ/BTU for generator set operating at FULL load and ALL connected appliance loads. Be sure to correct for weather evaporation.                                                     |                                   |  |
| M                                            | Sediment trap                                                                                                                                                                                                                       |                                   |  |

**Figure 3-4. LP Gas Vapor Installation (typical)**

**Table 11. Fuel Pipe Sizing LP Vapor (LPV) 10–14 in water column (2.488–3.487 kPa)**

**NOTE:** This table is for the length of low pressure fuel pipe between the secondary regulator and the generator.

| kW         | Pipe Size<br>(in / mm) | Allowable Pipe Distances (ft / m) |           |           |           |           |            |            |            |
|------------|------------------------|-----------------------------------|-----------|-----------|-----------|-----------|------------|------------|------------|
|            |                        | 0.5 / 13                          | 0.75 / 19 | 1 / 25    | 1.25 / 32 | 1.5 / 38  | 2 / 51     | 2.5 / 63   | 3 / 76     |
| 7.5        |                        | 40 / 12                           | 150 / 46  | 500 / 152 |           |           |            |            |            |
| 10         |                        | 40 / 12                           | 150 / 46  | 500 / 152 |           |           |            |            |            |
| 13         |                        |                                   | 60 / 18   | 200 / 61  |           |           |            |            |            |
| 15 ECO     |                        |                                   | 50 / 15   | 160 / 49  | 600 / 183 |           |            |            |            |
| 16         |                        |                                   | 40 / 12   | 125 / 38  | 500 / 152 |           |            |            |            |
| 20         |                        |                                   | 20 / 7    | 90 / 27   | 350 / 107 | 700 / 213 |            |            |            |
| 20 kW-3Ph. |                        |                                   | 30 / 9    | 100 / 30  | 350 / 107 | 800 / 244 |            |            |            |
| 22         |                        |                                   | 20 / 7    | 80 / 24   | 300 / 91  | 650 / 198 |            |            |            |
| 24         |                        |                                   | 20 / 7    | 90 / 27   | 350 / 107 | 750 / 229 |            |            |            |
| 25         |                        |                                   | 10 / 3    | 50 / 15   | 200 / 61  | 450 / 137 |            |            |            |
| 27         |                        |                                   | 20 / 7    | 80 / 24   | 300 / 91  | 650 / 198 |            |            |            |
| 32         |                        |                                   | 20 / 7    | 60 / 18   | 200 / 61  | 500 / 152 | 1700 / 518 |            |            |
| 38         |                        |                                   | 10 / 3    | 80 / 24   | 175 / 53  | 400 / 122 | 1400 / 427 |            |            |
| 45         |                        |                                   |           | 20 / 7    | 80 / 24   | 175 / 53  | 600 / 183  | 1400 / 427 |            |
| 48         |                        |                                   |           | 20 / 7    | 80 / 24   | 150 / 46  | 550 / 168  | 1300 / 396 |            |
| 60         |                        |                                   |           | 10 / 3    | 60 / 18   | 125 / 38  | 450 / 137  | 1100 / 335 |            |
| 70         |                        |                                   |           | 10 / 3    | 40 / 12   | 90 / 27   | 300 / 91   | 750 / 229  |            |
| 100        |                        |                                   |           | 30 / 9    |           | 60 / 18   | 200 / 61   | 500 / 152  | 1400 / 427 |
| 130        |                        |                                   |           |           | 10 / 3    | 30 / 9    | 100 / 30   | 250 / 76   | 750 / 229  |
| 150        |                        |                                   |           |           | 10 / 3    | 20 / 7    | 80 / 24    | 200 / 61   | 550 / 168  |

**NOTE:**

- Pipe sizing is based on 0.5 in water column pressure drop.
- Verify adequate service and meter sizing.
- Tables based on schedule 40 black pipe.

**NOTE:** Size fuel pipe according to sizing charts or local codes. When installing fuel piping other than Sch. 40 black pipe, see manufactures sizing charts and size that product to comply with the requirements outlined here-in.

**The piping system between the primary pressure regulator and generator must be correctly sized to provide fuel volume required at 100% load, while also staying within pressure range noted on unit specification sheet.**

| Table 12. LPV Weights and Measures |                          |
|------------------------------------|--------------------------|
| Units of Measure                   | Equivalent Units         |
| 1 US Gallon                        | 4.23 Pounds              |
| 1 US Gallon                        | 91,502 BTU @ 60°F        |
| 1 cubic foot                       | 2,488 BTU @ 60°F         |
| 1 US Gallon                        | 36.4 ft <sup>3</sup> Gas |
| 1 Liter                            | 23,700 BTU               |
| 1 Pound                            | 8.55 ft <sup>3</sup>     |
| 1 in Hg                            | 13.61 in water column    |
| 1 in water column                  | 0.249 kPa                |
| 11–14 in water column              | 2.739–3.487 kPa          |

| Table 13. Equivalent Straight Lengths in Ft / M of Sch. 40 Pipe Fittings and Valves |             |             |             |              |
|-------------------------------------------------------------------------------------|-------------|-------------|-------------|--------------|
| Pipe Size<br>(in / mm)                                                              | 45° Elbow   | 90° Elbow   | Tee Fitting | Fuel Shutoff |
| 0.75 / 19                                                                           | 0.96 / 0.29 | 2.06 / 0.63 | 4.12 / 1.25 | 0.48 / 0.14  |
| 1 / 25                                                                              | 1.22 / 0.37 | 2.62 / 0.80 | 5.24 / 1.60 | 0.61 / 0.18  |
| 1.25 / 32                                                                           | 1.61 / 0.49 | 3.45 / 1.0  | 6.9 / 2.10  | 0.81 / 0.25  |
| 1.5 / 38                                                                            | 1.88 / 0.57 | 4.02 / 1.22 | 8.04 / 2.45 | 0.94 / 0.29  |
| 2 / 51                                                                              | 2.41 / 0.73 | 5.17 / 1.57 | 10.3 / 3.14 | 1.21 / 0.37  |
| 2.5 / 63                                                                            | 2.88 / 0.88 | 6.16 / 1.88 | 12.3 / 3.75 | 1.44 / 0.44  |
| 3 / 76                                                                              | 3.58 / 1.10 | 12.6 / 3.84 | 15.3 / 4.66 | 1.79 / 0.55  |

| Table 14. LP Vapor (LPV) Tank Sizing                                                                                       |                                |                                     |                                 |                  |                    |                          |
|----------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------------|---------------------------------|------------------|--------------------|--------------------------|
| Total Tank Capacity (Gal / L)                                                                                              | Usable Tank Capacity (Gal / L) | Minimum Temp (°F / °C)              | Tank Capacity (BTU/hr)          | Length (in / mm) | Diameter (in / mm) | Overall Height (in / mm) |
| 120 / 454*                                                                                                                 | 72 / 272                       | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 246,240<br>164,160<br>82,080    | 57 / 1448        | 24 / 610           | 33 / 838                 |
| 150 / 567*                                                                                                                 | 90 / 340                       | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 293,760<br>195,840<br>97,920    | 68 / 1727        | 24 / 610           | 33 / 838                 |
| 250 / 946                                                                                                                  | 150 /                          | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 507,600<br>338,400<br>169,200   | 94 / 2388        | 30 / 762           | 39 / 991                 |
| 325 / 1230                                                                                                                 | 195 / 567                      | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 642,600<br>428,400<br>214,200   | 119 / 3023       | 30 / 762           | 39 / 991                 |
| 500 / 1892                                                                                                                 | 300 / 1135                     | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 792,540<br>528,360<br>264,180   | 119 / 3023       | 37 / 940           | 46 / 1168                |
| 850 / 3217                                                                                                                 | 510 / 1930                     | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 1,217,700<br>811,800<br>405,900 | 165 / 4191       | 41 / 1041          | 50 / 1270                |
| 1,000 / 3785                                                                                                               | 600 / 2271                     | 40 / 4.4<br>20 / -6.6<br>0 / -17.77 | 1,416,960<br>944,640<br>472,320 | 192 / 4877       | 41 / 1041          | 50 / 1270                |
| <b>NOTE:</b> Vertical tanks smaller than 120 pounds should be paralleled together to provide enough fuel to the generator. |                                |                                     |                                 |                  |                    |                          |

| Table 15. Fuel Required for Common Appliances                                       |                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------|
| Appliance                                                                           | Approximate Input BTU/hr                              |
| Warm air furnace<br>Single family<br>Multifamily (per unit)                         | 60,000–120,000<br>40,000–60,000                       |
| Hydronic boiler, space heating<br>Single family<br>Multifamily (per unit)           | 80,000–140,000<br>50,000–80,000                       |
| Hydronic boiler, space and water heating<br>Single family<br>Multifamily (per unit) | 100,000–200,000<br>50,000–100,000                     |
| Range, free standing, domestic                                                      | 50,000–90,000                                         |
| Built-in oven or broiler unit, domestic                                             | 14,000–16,000                                         |
| Built-in top unit, domestic                                                         | 40,000–85,000                                         |
| Water heater, automatic storage<br>30 to 40 gal tank<br>50 gal tank                 | 25,000–50,000<br>30,000–55,000                        |
| Water heater, automatic storage, instantaneous<br>2.5 gpm<br>3 gpm<br>4 gpm         | 115,000–125,000<br>125,000–150,000<br>155,000–200,000 |
| Water heater, domestic, circulating or side-arm                                     |                                                       |
| Refrigerator                                                                        | 1,500–2,000                                           |
| Clothes dryer, type 1 (domestic)                                                    | 18,000–22,000                                         |
| Gas fireplace direct vent                                                           | 20,000–90,000                                         |
| Gas log                                                                             | 35,000–90,000                                         |
| Barbecue                                                                            | 40,000–80,000                                         |
| Gas light                                                                           | 1,400–2,800                                           |

| Table 16. Generator Fuel Consumption – Gaseous |                     |         |                                 |        |                                |           |        |           |
|------------------------------------------------|---------------------|---------|---------------------------------|--------|--------------------------------|-----------|--------|-----------|
|                                                | Generator kW Rating |         | Fuel Consumption at 100% BTU/hr |        | Fuel Consumption at 50% BTU/hr |           |        |           |
|                                                | LP Vapor            | NG      | LP Vapor                        |        | NG                             | LP Vapor  |        | NG        |
|                                                |                     |         | BTU/hr                          | Gal/hr | BTU/hr                         | BTU/hr    | Gal/hr | BTU/hr    |
| Air-cooled                                     | 7.5                 | 6       | 129,000                         | 1.42   | 117,000                        | 79,000    | 0.87   | 73,000    |
|                                                | 10                  | 9       | 135,000                         | 1.48   | 127,000                        | 90,000    | 0.97   | 101,000   |
|                                                | 13                  | 13      | 223,000                         | 2.45   | 225,000                        | 140,000   | 1.54   | 154,000   |
|                                                | 15 ECO              | 15 ECO  | 251,000                         | 2.76   | 278,000                        | 167,000   | 1.84   | 195,000   |
|                                                | 16                  | 16      | 272,000                         | 2.99   | 245,000                        | 155,000   | 1.70   | 182,000   |
|                                                | 20                  | 18      | 324,000                         | 3.56   | 301,000                        | 216,000   | 2.38   | 204,000   |
|                                                | 20-3Ph.             | 17-3Ph. | 324,000                         | 3.56   | 307,000                        | 217,000   | 2.39   | 219,000   |
|                                                | 22/24               | 19.5    | 355,000                         | 3.87   | 327,000                        | 230,000   | 2.56   | 228,000   |
| Liquid-cooled                                  | 22                  | 22      | 309,000                         | 3.4    | 316,000                        | 191,000   | 2.1    | 190,000   |
|                                                | 25                  | 25      | 427,000                         | 4.7    | 430,000                        | 300,000   | 3.3    | 297,000   |
|                                                | 27                  | 25      | 354,000                         | 3.9    | 359,000                        | 191,000   | 2.1    | 197,000   |
|                                                | 30                  | 30      | 491,000                         | 5.4    | 492,000                        | 318,000   | 3.5    | 320,000   |
|                                                | 32                  | 32      | 418,000                         | 4.6    | 375,000                        | 246,000   | 2.7    | 226,000   |
|                                                | 36                  | 36      | 726,000                         | 8.0    | 730,000                        | 382,000   | 4.2    | 380,000   |
|                                                | 38                  | 38      | 472,000                         | 5.2    | 437,000                        | 264,000   | 2.9    | 255,000   |
|                                                | 45                  | 45      | 726,000                         | 8.0    | 730,000                        | 382,000   | 4.2    | 380,000   |
|                                                | 48                  | 48      | 601,000                         | 6.61   | 604,000                        | 378,000   | 4.16   | 394,000   |
|                                                | 60                  | 60      | 770,000                         | 8.4    | 808,000                        | 406,000   | 4.4    | 432,000   |
|                                                | 70                  | 67      | 1,028,000                       | 11.4   | 1,020,000                      | 496,000   | 5.46   | 500,000   |
|                                                | 80                  | 80      | 991,000                         | 10.8   | 1,063,000                      | 526,000   | 5.7    | 534,000   |
|                                                | 100                 | 94      | 1,268,000                       | 14.0   | 1,260,000                      | 718,000   | 7.9    | 713,000   |
|                                                | 130                 | 122     | 1,798,000                       | 19.8   | 1,786,000                      | 933,000   | 10.3   | 927,000   |
|                                                | 150                 | 142     | 2,080,000                       | 22.9   | 2,061,000                      | 1,080,000 | 11.9   | 1,070,000 |

**Table 17. Generator Fuel Consumption – Diesel**

| Size (kW)      % of Rated Load      Gal/hr      L/hr |      |      |       | Extended Tank               |                              | Up-Sized Tank               |                              |
|------------------------------------------------------|------|------|-------|-----------------------------|------------------------------|-----------------------------|------------------------------|
|                                                      |      |      |       | Total Capacity<br>(gal / L) | Usable Capacity<br>(gal / L) | Total Capacity<br>(gal / L) | Usable Capacity<br>(gal / L) |
| 15                                                   | 25%  | 0.6  | 2.27  | 33.5 G<br>17 L              | 32 G<br>121 L                | 98.5 G<br>372.9 L           | 95 G<br>359.6 L              |
|                                                      | 50%  | 0.85 | 3.22  |                             |                              |                             |                              |
|                                                      | 75%  | 1.1  | 4.16  |                             |                              |                             |                              |
|                                                      | 100% | 1.46 | 5.53  |                             |                              |                             |                              |
| 20                                                   | 25%  | 0.77 | 2.9   | 33.5 G<br>127 L             | 32 G<br>121 L                | 98.5 G<br>372.9 L           | 95 G<br>359.6 L              |
|                                                      | 50%  | 1.03 | 3.9   |                             |                              |                             |                              |
|                                                      | 75%  | 1.46 | 5.53  |                             |                              |                             |                              |
|                                                      | 100% | 1.97 | 7.46  |                             |                              |                             |                              |
| 30                                                   | 25%  | 0.97 | 3.67  | 61 G<br>233 L               | 57 G<br>215 L                | 138.5 G<br>524 L            | 132 G<br>500 L               |
|                                                      | 50%  | 1.37 | 5.19  |                             |                              |                             |                              |
|                                                      | 75%  | 1.97 | 7.46  |                             |                              |                             |                              |
|                                                      | 100% | 2.77 | 10.49 |                             |                              |                             |                              |
| 45/50                                                | 25%  | 1.35 | 5.11  | 62 G<br>234.7 L             | 57 G<br>215.8 L              | N/A                         |                              |
|                                                      | 50%  | 2.15 | 8.14  |                             |                              |                             |                              |
|                                                      | 75%  | 3.06 | 11.58 |                             |                              |                             |                              |
|                                                      | 100% | 3.98 | 15.07 |                             |                              |                             |                              |

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## 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 units with size ranges of 350–2,000 VA for passive, and 500–5,000 VA for line-interactive.

Passive UPS systems 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 load from input power to the internal DC to AC power inverter. Passive UPS systems do not correct for voltage or frequency deviations under “normal” operation.

Line-interactive is similar to passive technology except it has circuitry which 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 noisy. A single small UPS is not a significant concern, but applications with multiple UPS systems can be problematic.

Passive UPS technology typically has normal tolerances of 10–25% on voltage and 3 Hz on frequency. Minuteman UPS input tolerance is closer to 10–36%. UPS will switch to UPS battery source if input source goes outside of these tolerances. Some line-interactive units may have frequency tolerances factory set to 0.5 Hz. These units will need to have the frequency tolerance increased to a minimum of 2 Hz. Minuteman UPS products are closer to 5 Hz and not 0.5 hertz.

### Generator Sizing Recommendation

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

### Double-Conversion (also referenced as on-line)

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

There are single and three-phase models covering small to large applications. Most UPS applications larger than 5,000 VA use double conversion technology. This approach is also the preferred technology for generator applications.

### Equipment Notes

Single-phase or unfiltered three-phase double conversion UPS systems tend to create a significant level of electrical/harmonic noise. This is illustrated by harmonic current distortions 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 total UPS loading to 25% of the generator capacity.

Single-phase Minuteman UPS models: limit total UPS loading to 50% of the generator capacity.

Three-phase models without filters (current distortion > 30%): limit UPS loading to 35% of the generator capacity.

Three-phase models with filters (current distortion < 10%): limit UPS loading to 80% of the generator capacity.

### UPS Information

2 x kVA rating for a filtered system

3-5 x kVA rating for an unfiltered system

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

**NOTE:** Ferrups and Delta-Conversion UPS technologies not included in discussion.

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## UPS – Generator Compatibility Sizing Examples

- UPS systems create electrical or harmonic noise, which needs to be taken into consideration when sizing a generator.
- The generator alternator has to be sized large enough to accept the Total UPS Load from the connected UPS systems.
- Undersizing the generator can cause damage to the UPS equipment, connected equipment, and/or generator.

### Sizing Formula For UPS Systems

Number of Systems X VA Rating X Harmonic Multiplier X Generator Multiplier = Minimum Alternator Size

#### Single-phase generator backing up three, 2,500 VA Line-Interactive UPS Systems with a Harmonic Multiplier of 3

|                                   |            |
|-----------------------------------|------------|
| Number of UPS Systems             | 3          |
| VA Rating                         | 2,500      |
| Harmonic Multiplier               | 3          |
| Total UPS Load                    | 22,500 VA  |
| Generator Multiplier              | 4          |
| Minimum Generator Alternator Size | *90,000 VA |

(25% of the generator capacity)

\* Generator range is 80–100 kW depending on any voltage and frequency adjustments with the UPS system.

#### Three-phase generator backing up four, 10,000 VA Double Conversion UPS Systems with a Harmonic Multiplier of 2

|                                   |            |
|-----------------------------------|------------|
| Number of UPS Systems             | 4          |
| VA Rating                         | 10,000     |
| Harmonic Multiplier               | 2          |
| Total UPS Load                    | 80,000 VA  |
| Generator Multiplier              | 1.25       |
| Minimum Generator Alternator Size | 100,000 VA |

(80% of the generator capacity)

### Sizing Notes:

- Always contact the UPS manufacturer when in doubt of the Harmonic Multiplier for the UPS system.
- Always use the full VA rating of the UPS system for sizing calculations.
- Limit Total UPS loading on single-phase generators to 25% of the generators capacity.
- Limit Total UPS loading on three-phase generators to 80% of the generators capacity.

**Table 18. NEC (700, 701, 702) Comparison**

|                            | Article 700 - Emergency      | Article 701 - Standby                                                        | Article 702 - Optional Standby               |
|----------------------------|------------------------------|------------------------------------------------------------------------------|----------------------------------------------|
| Scope                      | Life safety                  | Legally required critical support<br>(fire fighting, health hazards,<br>etc) | Protect property & facilities                |
| Equipment approval         | For Emergency / (UL2200)     | For Intended Use / (UL2200)                                                  | For Intended Use / (UL2200) /<br>Not in 2008 |
| Testing                    | Witness Testing (on-sight)   | At install & periodically                                                    | At install                                   |
|                            | Periodic testing             | Yes                                                                          | Yes                                          |
|                            | Battery maintenance          | Yes                                                                          | Yes                                          |
|                            | Maintenance records          | Yes                                                                          | Yes                                          |
|                            | Load testing                 | Yes                                                                          | Yes                                          |
|                            | Capacity                     | All Loads                                                                    | All loads intended to operate at<br>one time |
|                            | Other standby loads allowed  | Yes with load shedding                                                       | Yes with load shedding                       |
|                            | Peak shaving allowed         | Yes                                                                          | Yes                                          |
| Transfer Switch            | Automatic                    | Yes                                                                          | Yes                                          |
|                            | Equipment approval           | For Emergency / (UL1008)                                                     | For Standby / (UL1008)                       |
|                            | Means to permit bypass       | Yes                                                                          | No                                           |
|                            | Elect. operated - mech. held | Yes                                                                          | No                                           |
|                            | Max. fault current capable   | Yes                                                                          | Yes                                          |
| Signals (Audible & Visual) | Malfunction                  | Yes / Standard common alarm                                                  | Yes / Standard common alarm                  |
|                            | Carrying load                | Yes / Displayed at ATS                                                       | Yes / Displayed at ATS                       |
|                            | Battery charger failed       | Yes                                                                          | Yes                                          |
|                            | Ground fault indication      | Yes (480V & 1000A)                                                           | No                                           |
|                            | NFPA 110 signaling           | Yes / Optional annunciator                                                   | Yes / Optional annunciator                   |
| Signs                      | At service                   | Yes / Type and location                                                      | Yes / Type and location                      |
|                            | At neutral to ground bonding | Yes (if remote)                                                              | Yes (if remote)                              |
|                            | Wiring kept independent      | Yes                                                                          | Yes                                          |
|                            | Fire protection (ref 700-9d) | Yes (1000 persons or 75'<br>building)                                        | No                                           |
|                            | Maximum power outage         | 10 sec                                                                       | 60 sec                                       |
|                            | Retransfer delay             | 15 min setting                                                               | 15 min setting                               |
|                            | Automatic starting           | Yes                                                                          | Yes                                          |
|                            | On-site fuel requirements    | See NFPA 110                                                                 | See NFPA 110                                 |
|                            | Battery charger              | Yes                                                                          | Yes                                          |
|                            | Ground fault                 | Indication only                                                              | No                                           |

# Electrical Formulas, Weights and Measures

| To Find                 | Known Values                  | Single-phase                                                     | Three-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                                                     | $E \times I \times 1.73 \times PF$                               |
| No. of Rotor Poles      | Frequency, Rpm                | $\frac{2 \times 60 \times \text{Frequency}}{RPM}$                | $\frac{2 \times 60 \times \text{Frequency}}{RPM}$                |
| Frequency               | Rpm, No. of Rotor Poles       | $\frac{RPM \times \text{Poles}}{2 \times 60}$                    | $\frac{RPM \times \text{Poles}}{2 \times 60}$                    |
| Rpm                     | Frequency, No. of Rotor Poles | $\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$ | $\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$ |
| kW (required for Motor) | Motor Horsepower, Efficiency  | $\frac{HP \times 0.746}{\text{Efficiency}}$                      | $\frac{HP \times 0.746}{\text{Efficiency}}$                      |
| Resistance              | Volts, Amperes                | $\frac{E}{I}$                                                    | $\frac{E}{I}$                                                    |
| Volts                   | Ohm, Amperes                  | $I \times R$                                                     | $I \times R$                                                     |
| Amperes                 | Ohms, Volts                   | $\frac{E}{R}$                                                    | $\frac{E}{R}$                                                    |

E = Volts

I = Amperes

R = Resistance (Ohms)

PF = Power Factor

## Explanation Of Scientific Notation

Scientific Notation is simply 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 (indicating 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.

Example: 186,000 =  $1.86 \times 10^5$       0.000524 =  $5.24 \times 10^{-4}$

## Useful Conversions / Equivalents

1 BTU.....Raises 1 lb of water 1 °F  
 1 GRAM CALORIE .....Raises 1 g of water 1 °C  
 1 CIRCULAR MIL.....Equals 0.7854 Square mil  
 1 SQ. MIL.....Equals 1.27 cir. mils  
 1 MIL.....Equals 0.001 in

## To determine circular mil of a conductor:

ROUND CONDUCTOR ...CM = (Diameter in mils)<sup>2</sup>

BUS BAR .....CM =  $\frac{\text{Width (mils)} \times \text{Thickness (mils)}}{0.7854}$

NOTES: 1 Millimeter = 39.37 Mils

1 Cir. Millimeter = 1550 Cir. Mils

1 Sq. Millimeter = 1974 Cir. Mils

## METRIC DESIGNATOR AND TRADE SIZES

| METRIC DESIGNATOR |     |     |    |       |       |    |       |    |       |     |     |     |
|-------------------|-----|-----|----|-------|-------|----|-------|----|-------|-----|-----|-----|
| 12                | 16  | 21  | 27 | 35    | 41    | 53 | 63    | 78 | 91    | 103 | 129 | 155 |
| 3/8               | 1/2 | 3/4 | 1  | 1-1/4 | 1-1/2 | 2  | 2-1/2 | 3  | 3-1/2 | 4   | 5   | 6   |
| TRADE SIZES       |     |     |    |       |       |    |       |    |       |     |     |     |

**Table 19. U.S. Weights & Measures / Metric Equivalent Chart**

|             | In      | Ft        | Yd                      | Mi                      | Mm              | Cm              | M         | Km                     |
|-------------|---------|-----------|-------------------------|-------------------------|-----------------|-----------------|-----------|------------------------|
| 1 Inch =    | 1       | 0.0833    | 0.0278                  | $1.578 \times 10^{-5}$  | 25.4            | 2.54            | 0.0254    | $2.54 \times 10^{-5}$  |
| 1 Foot =    | 12      | 1         | 0.333                   | $1.894 \times 10^{-1}$  | 304.8           | 30.48           | 0.3048    | $3.048 \times 10^{-4}$ |
| 1 Yard =    | 36      | 3         | 1                       | $5.6818 \times 10^{-4}$ | 914.4           | 91.44           | 0.9144    | $9.144 \times 10^{-4}$ |
| 1 Mile =    | 63360   | 5280      | 1760                    | 1                       | 1,609,344       | 160,934.40      | 1609.344  | 1.609344               |
| 1 mm =      | 0.03937 | 0.0032808 | $1.0936 \times 10^{-3}$ | $6.2137 \times 10^{-7}$ | 1               | 0.1             | 0.001     | 0.000001               |
| 1 cm =      | 0.3937  | 0.0328084 | 0.0109361               | $6.2137 \times 10^{-6}$ | 10              | 1               | 0.01      | 0.00001                |
| 1 m =       | 39.37   | 3.28084   | 1.09361                 | $6.2137 \times 10^{-4}$ | 1000            | 100             | 1         | 0.001                  |
| 1 km =      | 39370   | 3280.84   | 1,093.61                | 0.62137                 | 1,000.000       | 100,000         | 1,000     | 1                      |
| In = Inches |         | Ft = Foot | Yd = Yard               | Mi = Mile               | Mm = Millimeter | Cm = Centimeter | M = Meter | Km = Kilometer         |

## U.S. Weights And Measures

### Linear Measure

|            |             |                     |
|------------|-------------|---------------------|
|            | = 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 MILE  | = 5,280 FEET  |
| 1 SCOTS MILE    | = 5,952 FEET  |
| 1 IRISH MILE    | = 6,720 FEET  |
| 1 RUSSIAN VERST | = 3,504 FEET  |
| 1 ITALIAN MILE  | = 4,401 FEET  |
| 1 SPANISH MILE  | = 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 Measure

|                     |                 |
|---------------------|-----------------|
| 144 SQUARE INCHES   | = 1 SQUARE FOOT |
| 9 SQUARE FEET       | = 1 SQUARE YARD |
| 30 1/4 SQUARE 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 CUBIC FOOT        | = 1728 CUBIC INCHES             |
| 1 CUBIC YARD        | = 27 CUBIC FEET                 |
| 1 CUBIC FOOT        | = 7.48 GALLONS                  |
| 1 GALLON (WATER)    | = 8.34 LBS.                     |
| 1 GALLON (U.S.)     | = 231 CUBIC INCHES OF WATER     |
| 1 GALLON (IMPERIAL) | = 277 1/4 CUBIC INCHES OF WATER |

## 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 Measure

(THE UNIT IS THE METER = 39.37 INCHES)

|              |                  |                    |
|--------------|------------------|--------------------|
| 8 FURLONGS   | = 1 MILE         | = 1.609 KILOMETERS |
| 1 CENTIMETER | = 10 MILLIMETERS | = 0.3937011 INCH   |
| 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 Measure

(THE UNIT IS THE SQUARE METER = 1549.9969 SQUARE INCHES)

|                  |                       |                     |
|------------------|-----------------------|---------------------|
| 1 SQ. CENTIMETER | = 100 SQ. MILLIMETERS | = 0.1550 SQ. INCH   |
| 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 FEET  |
| 1 STERE     | = 10 DECISTERES  | = 1.307986 CUBIC YARDS |
| 1 DEKASTERE | = 10 STERES      | = 13.07986 CUBIC YARDS |

### Cubic Measure

(THE UNIT IS THE METER = 39.37 INCHES)

|                              |                        |                     |
|------------------------------|------------------------|---------------------|
| 1 DECISTERE                  | = 10 CENTISTERES       | = 3.531562 CU. FEET |
| 1 CU. CENTIMETER             | = 1000 CU. MILLIMETERS | = 0.06102 CU. INCH  |
| 1 CU. DECIMETER              | = 1000 CU. CENTIMETERS | = 61.02374 CU. INCH |
| 1 CU. METER                  | = 1000 CU. DECIMETERS  | = 35.31467 CU. FEET |
|                              | = 1 STERE              | = 1.30795 CU.       |
| 1 CU. CENTIMETER (WATER)     |                        | = 1 GRAM            |
| 1000 CU. CENTIMETERS (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 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        | = 2204.622/621849 POUNDS |
| 1 GRAM       | = 0.56438 DRAMS     |                          |
| 1 DRAM       | = 1.77186 GRAMS     |                          |
|              | = 27.3438 GRAINS    |                          |
| 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 BUSHEL        |
| 1 KILOLITER  | = 10 HECTOLITERS | = 264.2 GALLONS      |

NOTE: KILOMETERS x 5 = MILES or MILES x 8 = KILOMETERS

8

5

## Selected Circuit Load Calculator

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      ☐ 150 Amp      ☐ 200 Amp      ☐ 300 Amp

☐ 400 Amp      ☐ 600 Amp      ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

**Install Notes:**

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87 Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History Method 220.87 2020 NEC

Many 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

1. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
2. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
3. 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):

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:

(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest

cycling motor:

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:

\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

4. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
5. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

Fast food, convenience stores, restaurants, grocery stores

$kW = 50 \text{ kW} + 10 \text{ watts/sq. ft.}$

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

Square footage = \_\_\_\_\_ Estimated kW = \_\_\_\_\_

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating
- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

#### APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA - 10,000) x 0.40</u>    |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

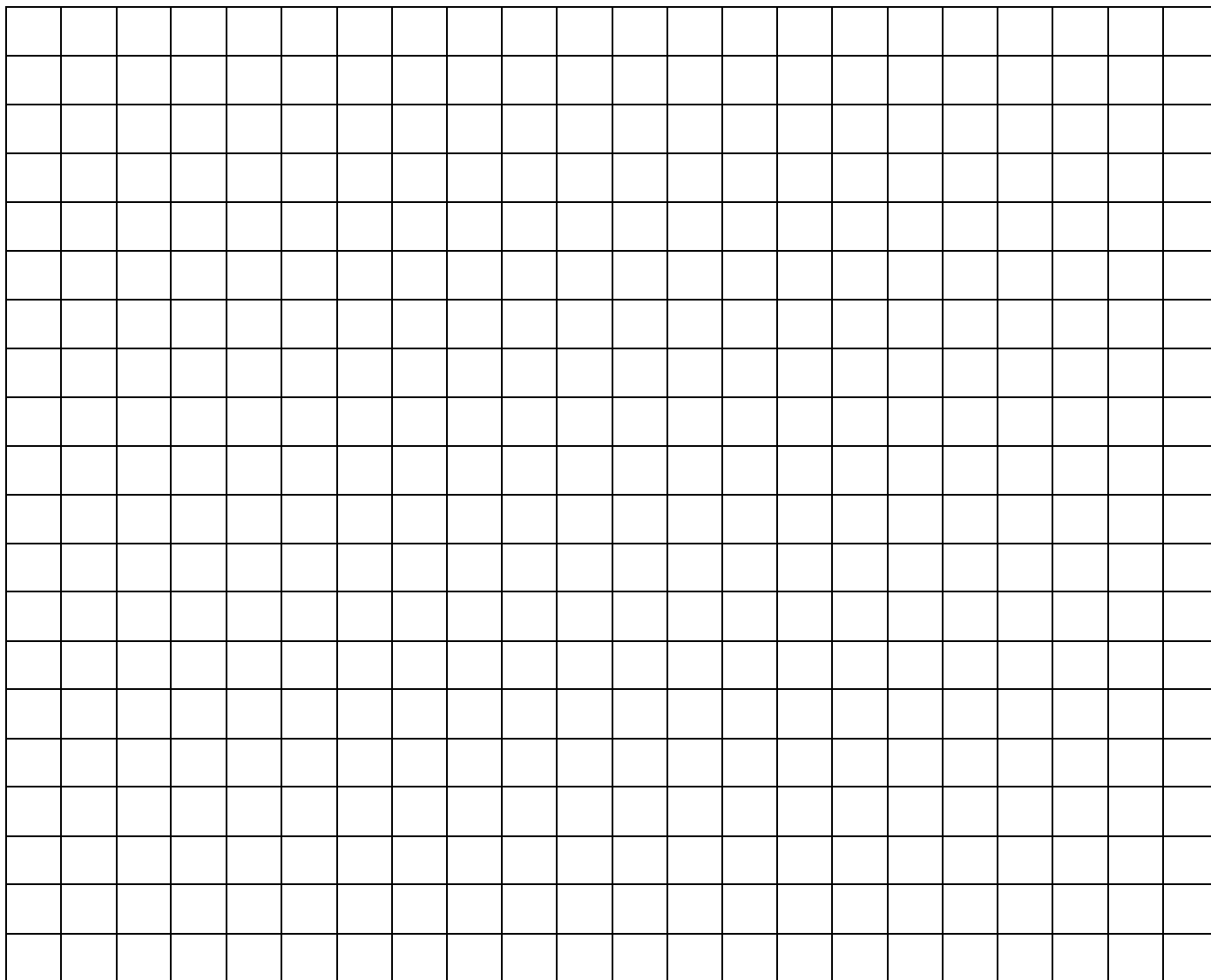
Converting VA to kW (Single-phase applications with 1.0 power factor only) 1 kVA = 1 kW

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes



## Selected Circuit Load Calculator

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      ☐ 150 Amp      ☐ 200 Amp      ☐ 300 Amp

☐ 400 Amp      ☐ 600 Amp      ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

### Install Notes:

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87 Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History Method 220.87 2020 NEC

Many 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

6. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
7. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
8. 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):

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:

(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest  
cycling motor:

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:

\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

9. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
10. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

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 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

#### APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA- 10,000) x 0.40</u>     |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes

[illegible]

## Selected Circuit Load Calculator

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      ☐ 150 Amp      ☐ 200 Amp      ☐ 300 Amp

☐ 400 Amp      ☐ 600 Amp      ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

### Install Notes:

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87

#### Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History

#### Method 220.87 2020 NEC

Many 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

11. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
12. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
13. 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):

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:

(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest

cycling motor:

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:

\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

14. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
15. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module

#### 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

Fast food, convenience stores, restaurants, grocery stores

$kW = 50 \text{ kW} + 10 \text{ watts/sq. ft.}$

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

Square footage = \_\_\_\_\_ Estimated kW = \_\_\_\_\_

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA- 10,000) x 0.40</u>     |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes

[illegible]

## Selected Circuit Load Calculator

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    ☐ 150 Amp    ☐ 200 Amp    ☐ 300 Amp  
                          ☐ 400 Amp    ☐ 600 Amp    ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

### Install Notes:

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87 Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History Method 220.87 2020 NEC

Many 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

16. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
17. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
18. 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):

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:

(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest  
cycling motor:

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:

\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

19. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
20. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

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 = \_\_\_\_\_

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø:                      Amps x 0.17 =                      kW

480 Volts, 3 Ø:                      Amps x 0.34 =                      kW

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

#### APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA - 10,000) x 0.40</u>    |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes

[illegible]

## Selected Circuit Load Calculator

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    ☐ 150 Amp    ☐ 200 Amp    ☐ 300 Amp  
                          ☐ 400 Amp    ☐ 600 Amp    ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

### Install Notes:

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87 Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History Method 220.87 2020 NEC

Many 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

21. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
22. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
23. 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):  
(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:  
(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest  
cycling motor:  
(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:  
\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

24. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
25. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.10 = \_\_\_\_\_ kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

Fast food, convenience stores, restaurants, grocery stores

$\text{kW} = 50 \text{ kW} + 10 \text{ watts/sq. ft.}$

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

Square footage = \_\_\_\_\_ Estimated kW = \_\_\_\_\_

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA- 10,000) x 0.40</u>     |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes

[illegible]

## Selected Circuit Load Calculator

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    ☐ 150 Amp    ☐ 200 Amp    ☐ 300 Amp  
                          ☐ 400 Amp    ☐ 600 Amp    ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

### Install Notes:

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87 Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History Method 220.87 2020 NEC

Many 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

26. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
27. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
28. 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):  
(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:  
(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest  
cycling motor:  
(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:  
\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

29. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
30. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

### Smart Management Module 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

Fast food, convenience stores, restaurants, grocery stores

$kW = 50 \text{ kW} + 10 \text{ watts/sq. ft.}$

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

Square footage = \_\_\_\_\_ Estimated kW = \_\_\_\_\_

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA - 10,000) x 0.40</u>    |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

[illegible][illegible]

## Selected Circuit Load Calculator

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    ☐ 150 Amp    ☐ 200 Amp    ☐ 300 Amp  
                          ☐ 400 Amp    ☐ 600 Amp    ☐ Other \_\_\_\_\_

**Before installation, contact local jurisdiction to verify all requirements are met. Jurisdictions may vary.**

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

**Use the following for sizing and determining generator kW.**

| Worksheet 1. Motor Loads |    |    |     |                   |              |
|--------------------------|----|----|-----|-------------------|--------------|
| Device                   | HP | RA | LRA | kW Running (= HP) | Starting kW* |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |
|                          |    |    |     |                   |              |

\*See Table 430.7(B) for starting kVA per HP for motor loads.

| Worksheet 2. Non-Motor Loads |      |    |
|------------------------------|------|----|
| Device                       | Amps | kW |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |
|                              |      |    |

| 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 |

**Install Notes:**

1. See manual for installation recommendations.
2. Contact AHJ for local requirements.

**Recommended Generator Size** \_\_\_\_\_ See Generator Sizing Instructions on other side of this sheet.

## Generator Sizing Instructions

There are multiple ways to size a generator. The following are methods which, when combined with good judgment, 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 2020 NEC Electrical Code, there may be new sizing requirements which the installation technician must follow. Consult with the local inspection department to verify which code cycle will affect the installation.

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 correctly accounting for the power factor and/or mixing voltages will result in incorrectly sizing the generator.

When a motor starts, a current surge is created that step loads the generator and causes a voltage dip. After selecting a generator, see the generator's surge capability using [Table 5](#), [Table 6](#), and [Table 7](#). Verify voltage dip is adequate for the application. Most commercial applications should be limited to approximately 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. See [UPS – Generator Compatibility](#) for this load type.

### Measurement Method 220.87

#### Exception 2020 NEC

Connect a recording ammeter or power meter capable of measuring maximum peak kW demand continuously over a minimum 30 day period. The maximum kW demand shall be taken while the building is occupied and shall include the larger of the heating or cooling loads. The peak kW demand shall be multiplied by 125%.

Peak kW demand X 125% = Calculated kW demand

Size the generator to the next standard size and verify UPS and motor load compatibility.

### Determining Existing Loads/Billing History

#### Method 220.87 2020 NEC

Many 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

31. Enter running kW for all motor loads (except the largest) expected to run during peak load levels into the [Worksheet 1](#). See [Table 1](#) and [Table 2](#) for typical motor load sizes and electrical requirements.
32. Enter kW for all non-motor loads expected to run during peak load levels into [Worksheet 2](#). See [Table 3](#) for typical residential loads and rules of thumb.
33. 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):

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Non-motor load total:

(from [Worksheet 2](#)) \_\_\_\_\_ kW

Starting load from largest

cycling motor:

(from [Worksheet 1](#)) \_\_\_\_\_ kW

Total electrical loads:

\_\_\_\_\_ kW

Select generator:

Commercial (add 20 to 25% to total kW)

Residential (add 10 to 20% to total kW)

34. Verify voltage dip is within acceptable limits by comparing motor LRA to generator surge capability (see [Table 5](#), [Table 6](#), and [Table 7](#)).
35. Verify UPS compatibility (see [UPS – Generator Compatibility](#)).

## System Capacity – Load Calculation

If the local municipality or state the installation is in has adopted the 2020 NEC Code, this step may be required. Article 702 of the 2020 NEC includes a new requirement for sizing (702.4). If no other method for sizing is acceptable, sizing of the generator shall be made in accordance with Article 220 of the 2020 NEC. Use the system capacity estimating sheet as a guide for this process.

## Smart Management Module

### 702.4 (B) (2) (a) 2020 NEC

The Smart Management Module (SMM) is a contact (50 or 100 amp) housed in a NEMA 3R enclosure for indoor and outdoor installation applications. Through the use of SMM's in conjunction with any of the 100–600 amp Smart Switches, household or business loads can be intelligently managed, enabling the use of a smaller, more efficient generator system. Up to eight SMM's can be used with a single switch.

[illegible]

### Estimate Based On Square Footage

**Estimate based on 60% service size: (Commercial)**

240 Volts, 1 Ø: \_\_\_\_\_ Amps x 0.15 = \_\_\_\_\_ kW

208 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.22 = \_\_\_\_\_ kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.25 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.50 = \_\_\_\_\_ kW

### Estimate Based On 40% Service Size: (Residential)

240 Volts, 1 Ø:                      Amps x 0.10 =                      kW

208 Volts, 3 Ø:                      Amps x 0.15 =                      kW

240 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.17 = \_\_\_\_\_ kW

480 Volts, 3 Ø: \_\_\_\_\_ Amps x 0.34 = \_\_\_\_\_ kW

Fast food, convenience stores, restaurants, grocery stores

$kW = 50 \text{ kW} + 10 \text{ watts/sq. ft.}$

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

Square footage = \_\_\_\_\_ Estimated kW = \_\_\_\_\_

### Amps to kW Rule of Thumb (assumes 0.8 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 2020 NEC, 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 calculated load will be the result of adding

- 220.82 (B) General Loads, and
- 220.82 (C) Heating and Air-Conditioning Load

220.82 (C)

#### GENERAL LOADS

220.82 (B)

General Lighting and General-Use Receptacles

- Calculate at 3 VA per square foot
  - 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
- Calculate the following loads at 100% of nameplate rating
- Appliances fastened in place, permanently connected or located on a specific circuit
  - Ranges, wall-mounted ovens, counter-mounted cooking units
- Clothes dryers not connected to the laundry branch circuit
- Water heaters
- Permanently connected motors not included in Heat & Air-Conditioning Load section

220.82 (B) (1)

220.82 (B) (2)

220.82 (B) (3)

220.82 (B) (3) a

220.82 (B) (3) b

220.82 (B) (3) c

220.82 (B) (3) d

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

220.82 (C) (1)

- 100% of nameplate rating

Heat Pumps without Supplemental Electric Heating

220.82 (C) (2)

- 100% of nameplate rating

Heat Pumps with Supplemental Electric Heating

220.82 (C) (3)

- 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 four separately controlled units @ 65% of nameplate rating
- Four or more separately controlled units @ 40% of nameplate rating
- 40% of nameplate rating if using four or more separately controlled units

220.82 (C) (4)

220.82 (C) (5)

Electric Thermal Storage (or system where the load is expected to be continuous at nameplate rating)

220.82 (C) (6)

- 100% of nameplate rating

- Systems of this type cannot be calculated under any other section of 220.82 (C).

#### LOAD CALCULATIONS

General Lighting Load

3 VA x ft<sup>2</sup>

- |                                                 |   |                                 |
|-------------------------------------------------|---|---------------------------------|
| • Small Appliance & Laundry Circuits            | + | 1500 VA per circuit             |
| • General Appliances & Motors (100% rated load) | + | <u>Total general appliances</u> |
| • Sum of all General Loads                      | = | Total General Load (VA)         |

APPLY DEMAND FACTORS

- |                                    |   |                                      |
|------------------------------------|---|--------------------------------------|
| – First 10 kVA @ 100%              | = | 10,000 VA                            |
| – Remainder of General Loads @ 40% | = | <u>(Total VA - 10,000) x 0.40</u>    |
|                                    | = | Calculated General Load (VA)         |
| • HEAT / A-C LOAD @ 100%           | = | <u>Largest Heat or A-C Load (VA)</u> |
|                                    | = | TOTAL CALCULATED LOAD                |

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

220.54

## Worksheet — 2020 NEC, 220 Part IV

| GENERAL LOADS                                                    | Qty | Rating (Load)       | Factor | Loads (VA)         | Loads (kW)<br>(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                                                            |     |                     | 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%   |                    |                            |
| <b>Total General Loads</b>                                       |     |                     |        | <b>VA</b>          | <b>kW</b>                  |
| <b>HEAT / A-C LOAD</b>                                           |     |                     |        |                    |                            |
| A-C / Cooling Equipment                                          |     |                     | 100%   |                    |                            |
| Heat Pump                                                        |     |                     |        |                    |                            |
| • Compressor (if not included as A-C)                            |     |                     | 100%   |                    |                            |
| • Supplemental Electric Heat                                     |     |                     | 65%    |                    |                            |
| Electric Space Heating                                           |     |                     |        |                    |                            |
| • Less than four separately controlled units                     |     |                     | 65%    |                    |                            |
| • Four or more separately controlled units                       |     |                     | 40%    |                    |                            |
| System With Continuous Nameplate Load                            |     |                     | 100%   |                    |                            |
| Largest Heat / A-C Load (VA) VA kW                               |     |                     |        |                    |                            |
| <b>General Loads</b>                                             |     |                     |        |                    |                            |
| • 1st 10 kW of General Loads 100% kW                             |     |                     | 100%   | <u>        </u> kW |                            |
| • Remaining General Loads (kW) 40% kW                            |     |                     | 40%    | <u>        </u> kW |                            |
| <b>Calculated General Load (kW) kW</b>                           |     |                     |        |                    | <u>        </u> kW         |
| <b>Largest Heat / A-C Load 100% kW kW</b>                        |     |                     |        |                    | <u>        </u> kW         |
| <b>Total Calculated Load (Net General Loads + Heat/A-C Load)</b> |     |                     |        |                    | <u>        </u> kW         |

Notes

[illegible]



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Generac Power Systems, Inc.  
S45 W29290 Hwy. 59  
Waukesha, WI 53189  
1-888-GENERAC (1-888-436-3722)  
[www.generac.com](http://www.generac.com)