



PDHonline Course E253 (1 PDH)

Service Calculations for Dwellings

Instructor: Dwight E. Beasley, PE

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5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

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Service Calculations for Dwellings

Dwight E. Beasley, PE

Course Content

The NEC® contains two methods for calculating the electrical service or feeders for dwelling units. The NEC® defines a dwelling unit as an independent living facility for one or more persons that contain permanent provisions for cooking, sanitary, living, and sleeping. In looking at the NEC® in trying to determine what values to use for the typical loads and sorting out what load goes to which factor is usually the most confusing part of performing the calculations. As is the case, the NEC® is not written as a design guide. Also, some interpretation by the Engineer may be necessary in some portions of the code.

A dwelling unit is defined as a single family home, duplex, apartment, condo, or hotel. A guest room within a hotel must contain cooking and sanitary provisions to meet the definition of a dwelling.

In order to perform a service calculation, the designer should obtain as much information as possible including the square footage of each unit type, all common areas, back-of-house areas, and all appliance cut-sheets or nameplate data. Most of this information is obtained from the architect, interior designers and mechanical or plumbing designers.

The service sizing sections are found in NEC® Article 220 Parts II, III, and IV. The Standard Calculation is defined in Part III and the Optional Calculation is defined in Part IV. The simplest and quickest method to use is the Optional Calculation. There are minimum requirements that the dwelling must meet in order to use this method. The dwelling must have a feeder voltage of 120/240 or 120/208V 3-wire and at least 100 amperes.

A single dwelling calculation is used for a stand alone building or within a multi-unit building. When determining the service for a multi-unit building, the designer is allowed to first calculate each individual dwelling, then use the multi-dwelling calculation for each feeder for a floor(s). Lastly, repeat the entire multi-dwelling calculation for the each building service, if there are multiple service disconnects.

Single Dwelling Unit Calculation

The total service is obtained by adding together the combination of loads typical for a modern house. Then a demand factor is applied to produce the total service. The following loads apply:

1. Multiply the total square footage of the unit as measured from the exterior walls by 3VA per square foot. This factor includes all the general purpose receptacles and lighting fixtures.

2. The kitchen requires a minimum of (2) two small appliance circuits of 1500VA each for a total of 3000VA. Study the kitchen plans to incorporate the necessary number of circuits. Also, some local jurisdictions restrict the number of outlets on each kitchen circuits. Be sure to research the local amendments to the NEC prior to performing the calculations.
3. The required laundry circuit is calculated at 1500VA. The dryer load is added below.
4. Add up all fastened-in-place appliances such as ranges, ovens, cooking units, clothes dryers, water heaters, dishwashers and other non-motor permanent devices.
5. All motor nameplate loads and low power factor loads.
6. Select the largest HVAC load. Compare the cooling and heating loads for the following systems types:
 - a. 100% of the air conditioning and cooling nameplate rating
 - b. 100% of the heating in a heat pump nameplate rating with no emergency heating
 - c. 100% of electric heating storage systems (i.e. water heater used in heating the living space)
 - d. 100% of the heat pump compressor plus 65% of the emergency heating load. The heating load is not added if the controls prevent both systems from operating at the same time.
 - e. If less than four HVAC units, multiply the heating load by 65%
 - f. If four HVAC units or more, multiply the heating load by 40%

Add #1 through #5 and apply the 100% factor to the first 10KVA and then apply the 40% to the remainder. Then add the HVAC load. For a single-phase service, divide by the line-to-line voltage (240 or 208) for the service in amps. For a three-phase service, divide by $208 \times \sqrt{3}$ for the service in amps. Confirm 3phase is available with your utility, but typically the service has to be over 800amps to justify a three-phase service.

Here's an example of a typical house with a 120/240V 3-wire service. The house is 2000 square feet with the following appliances and HVAC loads:

1. Dryer – 5000VA
2. Oven and range combination – 8000VA
3. Dishwasher – 1200VA
4. Disposal – 800VA
5. Water heater – 9000VA
6. Attic fan – 700VA
7. Wine cooler – 800VA
8. Central HVAC system with 8000VA compressor load, gas furnace and controls for either heat or cool only (assume the blower fan is included in the 8000VA)

Calculation: $2000\text{sf} \times 3\text{VA/sf} = 6000\text{VA}$
(2) small appliance circuits $\times 1500\text{VA/circuit} = 3000\text{VA}$
(1) laundry circuit $\times 1500\text{VA/circuit} = 1500\text{VA}$
add dryer (5000) + oven (8000) + dishwasher (1200) + disposal (800) +
range (8000) + water heater (9000) + fan (700) + wine cooler (800) =
33,500VA subtotal
HVAC (8000) $\times 100\% = 8000\text{VA}$

Take $100\% \times 10,000\text{VA} + 40\% \times (33,500 - 10,000) \text{VA} + 8000\text{VA} = 27,400\text{VA}$
Service size = $27,400/240 = 114\text{Amps}$. From the standard ampere rating in NEC® 240.6,
a 125amp breaker is adequate for the service size.

Optional Multi-Dwelling Calculation

Before using the Optional Calculation for three or more units, the designer must ensure that each unit is fed by a single feeder, contain cooking provisions, and have an air conditioning system integral to each unit.

The lobby, corridors, and other common areas are calculated per NEC® Part III of Article 220(determine the loads just like in a commercial building). These loads usually are fed and metered with a separate service.

The total dwelling service/feeders are calculated by adding the following loads:

1. Multiply the total square footage of the unit as measured from the exterior walls by 3VA per square foot. This factor includes all the general purpose receptacles and lighting.
2. The kitchen requires a minimum of (2) two small appliance circuits of 1500VA each for a total of 3000VA. Remember to research the local NEC code amendments for outlet requirements in the kitchen. Some local jurisdictions require additional small appliance circuits.
3. The required laundry circuit is calculated at 1500VA.
4. Add up all fastened-in-place appliances such as ranges, ovens, cooking units, clothes dryers, water heaters, dishwashers and other non-motor permanent devices.
5. All motor nameplate loads and low power factor loads.
6. The larger of the cooling or heating load.

Once all the loads are totalized for the service, the demand factor in Table 220.84 is used to determine the final electrical service size based on the total number of units. Depending on how the distribution system is organized, the calculation is repeated for each feeder. If a feeder is used for each floor or several floors, the engineer will repeat the calculation based on number of units per feeder and obtain the factor from Table 220.84 each time.

The student may notice that the only difference between the single and multi-unit calculation is in the cooling and heating portion of the methodology. In the single unit calculation, the type of system determined that portion of the load. In the multi-unit calculation, only the larger between cooling or heating is included.

Let's take a look at the same example from earlier but with 32 dwelling units and electric heating, voltage is 120/208V, 3phase:

1. Dryer – 5000VA
2. Oven and range combination – 8000VA
3. Dishwasher – 1200VA
4. Disposal – 800VA
5. Water heater – 9000VA
6. Attic fan – 700VA
7. Wine cooler – 800VA
8. Central HVAC system with 8000VA cooling load, 10,000VA heating and controls for either heat or cool only.

Calculation: $2000\text{sf} \times 3\text{VA/sf} = 6000\text{VA}$
(2) Small appliance circuits $\times 1500\text{VA/circuit} = 3000\text{VA}$
(1) laundry circuit $\times 1500\text{VA/circuit} = 1500\text{VA}$
Dryer (5000) + Oven (8000) + Disposal (800) + Range (8000)
+ Water heater (9000) + Fan (700) + wine cooler (800) = 32,300VA
Heat (10,000) $\times 100\% = 10,000\text{VA}$

Total load = $52,800\text{VA/unit} \times 32 \text{ units} \times .31(\text{demand from Table 220.84}) = 523,776\text{VA}$
Service size = $523,776\text{VA} / (208\sqrt{3}) = 1455\text{Amps}$. At this point, the actual breaker size is selected from the standard ampere ratings found in NEC® 240.6. A 1600amp breaker is adequate for the service size.

Wire sizes for the services are determined from NEC® Table 310.16 for the three-phase feeders and NEC® Table 310.15B for any single-phase, 120/240V feeders. This concludes our foray into the optional methods of sizing dwelling electrical services as per the National Electrical Code. Take the attached quiz to earn your PDH hours.