

How to Calculate Panelboard Ampacity

Why Electrical Panels need to be sized.



When most people walk into their office for work each morning, they take for granted the fact that the lights are on and their computers are running. In fact, nobody really appreciates the electrical power supplying these devices until there is a power outage. The truth is that sometime during the original planning and design of the building, an electrical engineer determined the size of the electrical distribution, specifically the panelboards where the lighting and power receptacles are supplied from. Calculations were made about the amount of power required for all lighting, power receptacles and all other equipment that was required in the scope of work. If careful planning is not performed during the design phase, it could result in a disaster later on in the project.

Note: For the sake of simplicity, this article will only discuss standard 42 circuit electrical panels, sometimes referred to as "lighting panels". And the loads discussed do not involve motors or hvac equipment.

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Ohm's Law

Let's discuss some technical items. In order to understand how to calculate panelboard ampacity, we must discuss how electrical design is defined in terms of volts (V), amperes (A) and watts (W). Ohm's Law formulates the theory behind electrical circuits by relating how voltage, current (amperes) and resistance (which won't be discussed in this article) work together. For more information about Ohm's Law and electricity, [click here](#).

We'll go through a sample calculation shortly but first, listed below are commonly used equations when calculating panelboard ampacity:

$$W = V \times A$$

$$A = \frac{W}{V}$$

$$KW = W \times 1,000$$

Sample Calculation

So these calculations are very simple, aren't they? There is a lot to know about clearances, hazardous locations, NEMA ratings, overcurrent protection and voltage drop but the math is not rocket science. Let's look at an example:

There is a 42 circuit panel which serves power receptacles and have determined that the

*total load (as measured in KW -- kilowatts) is 23.50kw. The voltage of the panel is 120/208v 3ø, 4w. **When sizing electrical panels, the two most important things to know about this given voltage is the higher size (208v) and the phasing (3-phase or 3ø).***

Step 1: Convert the load from KW to W.

$$23.50\text{kw} \times 1000 = 23,500\text{w}$$

Step 2: Divide the load by the voltage and multiply by 125% (safety factor required by NEC).

$$23,500 \div (208\text{v} \times \sqrt{3}) \times 1.25 = 81.54\text{amps}$$

Step 3: Use the result of of Step 2 to determine the panelboard ampacity.

The next size up from 81.54amps is 100amps. Therefore, the electrical panel in our example will be 100amps 120/208v 3ø, 4w. This happens to be a very common size.

One important thing to note: You'll notice in Step 2 that the square root of three was multiplied by the voltage. Without going into all the theory behind this, when the voltage is single phase, simply divide the wattage by that voltage. In the example above, it would be 208v. But if the voltage is considered three phase, the square root of three must be multiplied by that voltage.

Conclusion

Now that the panel is sized, provisions must be made to provide a 100amp circuit breaker (overcurrent protection) and 100amp-rated feeders and conduits which will serve this panel from its source of power. But the effort of sizing the panel is complete.

There you have it. Whether the voltage is 120/208v 3 ϕ , 4w or 120/240v 1 ϕ , 3w or 277/480v 3 ϕ , 4w, these calculations apply due to the relationship of volts, watts and amps as defined in Ohm's Law. These calculations happen all the time around the world as electrical engineers design the buildings of tomorrow.