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Understanding the Application

of 80%- and 100%-Rated *Circuit Breakers*

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INTRODUCTION

Selecting circuit breaker sizes and ratings is one of the most common tasks that electrical specifiers undertake. It is also a topic that has the most written code articles and therefore one of the more confusing subjects that is often discussed.

One of the underlying topics under this subject is standard- and 100%-rated breakers. This paper aims to provide additional perspective on this topic.

DEFINITIONS

Standard and 100% ratings are circuit breaker manufacturer ratings that guide the specifier on how the breaker is allowed to be applied based on the requirements of the National Electrical Code (NEC). To be clear, a standard-rated breaker (also known as 80%-rated) does not mean it will trip at 80% of the current rating.

All properly installed breakers are designed to carry 100% of their current rating for an indefinite period. This is a requirement driven by Underwriters Laboratory (UL) manufacturing standards; however, the NEC code dictates how circuit breakers are selected and applied.

APPLICATION OF CIRCUIT BREAKERS

The selection and application of a circuit breaker starts with the calculation and categorization of loads. The NEC contains many sections of load calculation and categorization, but for the purpose of this paper we will boil down the categories into continuous versus noncontinuous loads.

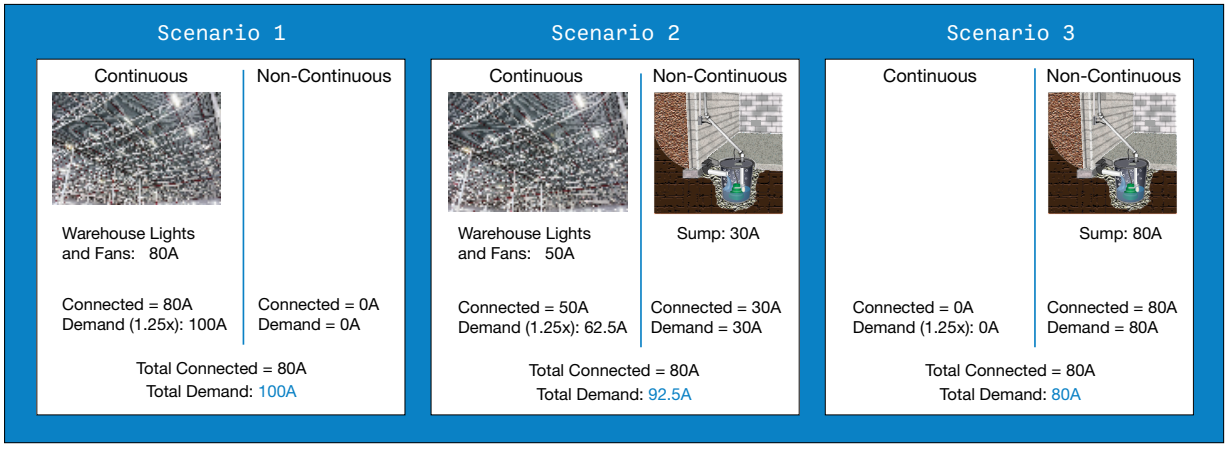
Continuous loads are defined in Article 240.20 (A) as equipment that will operate at full capacity for three consecutive hours. All other loads are categorized as noncontinuous loads. The total load on the circuit is calculated as the sum of noncontinuous loads plus 1.25 times the continuous loads. Let's consider the following application scenarios in Figure 1 below.

> Article 240.20 (A) of the National Electrical Code (NEC), 2014 Edition states: (A) Continuous and Noncontinuous Loads. Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.
>
> Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous loads plus the noncontinuous load.

In all three scenarios, the connected load is 80 A, but the demand load is different because NEC requires a 1.25 multiplier on continuous loads.

Scenarios 1 and 2 have a continuous load, so those values will be multiplied by 1.25 before adding to the total demand load. This difference in value between connected and demand load will now have to be considered when selecting the circuit breaker.

Figure 1

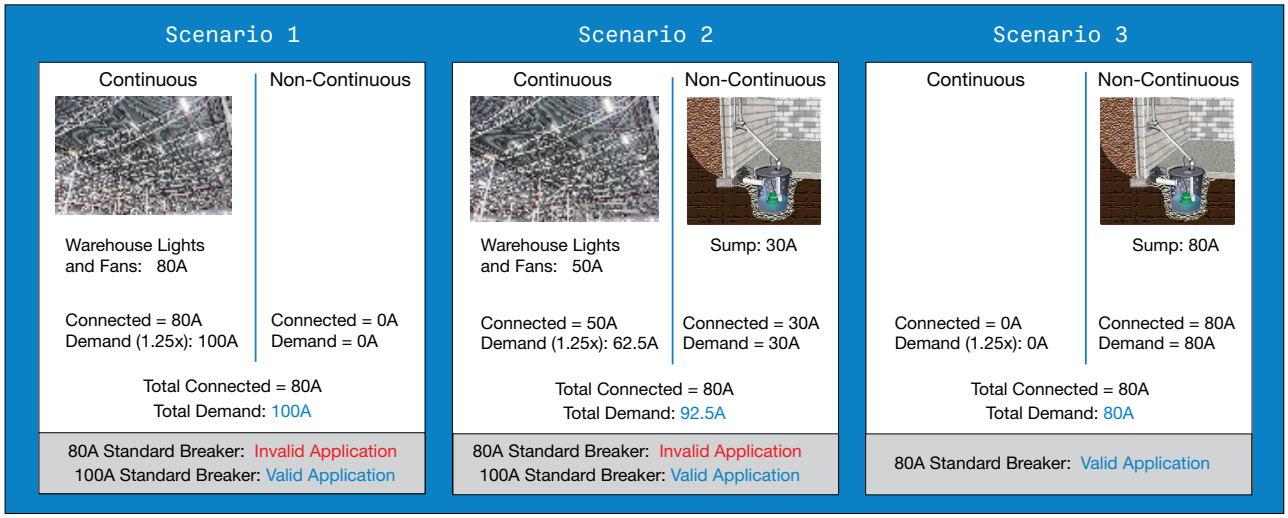


STANDARD 80%-RATED CIRCUIT BREAKERS

Let's start by considering an 80 A standard breaker and see where we may have met or violated the NEC in the above scenarios.

In scenarios 1 and 2 of Figure 2, the 80 A breaker is less than the calculated demand load of 100 amps and 92.5 amps, respectively; therefore it is not a valid application in violation of NEC article 240.20. We would have to use a larger breaker—a 100 A standard-rated would have to be considered. In scenario 3, an 80 A breaker would suffice as it does not have a continuous load and the demand load is equal to the connected load of 80 A, as it doesn't require a multiplier.

Figure 2



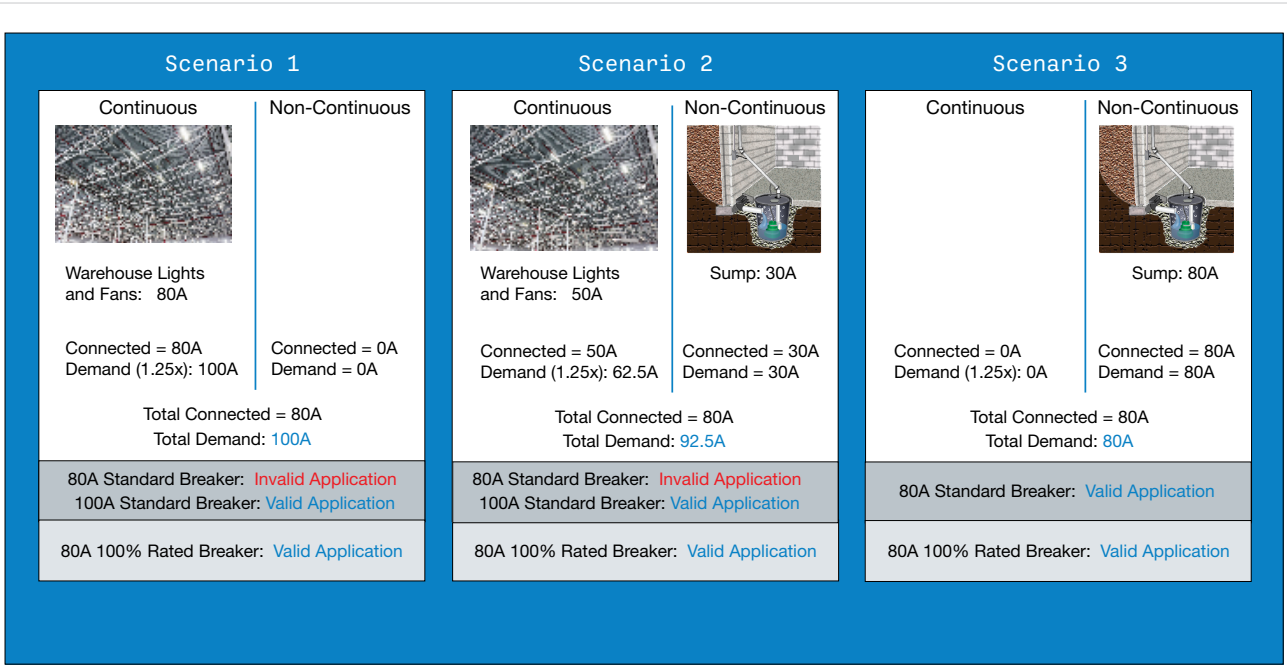
100%-RATED CIRCUIT BREAKERS

Now let's consider a 100%-rated breaker. Again, a reminder that UL requires breakers to be manufactured to carry the rated current for an indefinite period, but this time additional testing is performed.

The breakers are tested with specific enclosure clearances, terminations, cable sizes, and allowable temperature rise. Breakers tested under these stricter conditions that still perform at their current rating are now eligible to be marked and published by manufacturer as 100%-rated.

Referring to the three scenarios in Figure 3, an 80 A 100%-rated breaker would now be a valid choice for all three scenarios. The 100%-rated breaker is applicable to the total connected load, regardless of whether it is classified as continuous load or not. The total connected load for all three scenarios is 80 A, and an 80 A 100%-rated breaker is a valid application.

Figure 3



STANDARD VS. 100%

The specifier is now presented with a choice for scenarios 1 and 2. With standard ratings, the breaker must be at least 100 A, while if they consider 100%-rated breakers, the breaker can be 80 amps. The specifier must now consider this choice between the breakers, based on cost, availability, and installation complexity.

As stated above, the 100%-rated marking is based on a specific condition that has been subject to testing. Therefore, when selecting a 100%-rated breaker, the specifier must also take into consideration the proper installation of the breaker as well as all the conditions that the manufacturer enumerates to retain that rating. Additionally, because of the specific testing, 100%-rated circuit breakers are typically more expensive and less available than the 80%-rated circuit breakers. This should also be weighed for decision making.

Standard rated breakers are less expensive and are more available. It is quite common to use these breakers and select the larger size to account for any continuous loads in the system. Oftentimes the information to perform a load categorization and calculations are not available. This leads many specifiers to select standard-rated breakers and oversize them to at least 125% to account for any continuous loads in the system. Notice that the inverse of 125% is 80%. This is where the term 80% comes from. The term “standard breaker” is synonymous with “80%-rated breaker.”

SUMMARY

It is important to realize that standard-rated (80%-rated) and 100% rating of a breaker is not related to the tripping point of the breaker. It is the determination of what kind of application the breaker is rated for: continuous or noncontinuous. A 100A 80%-rated breaker does not mean the breaker will trip at 80 A. It means that it can only be applied to continuous loads that total 80 A. Meanwhile, a 100 A 100%-rated breaker can be applied to 100 A continuous loads.

The NEC does not address nor define what an 80% rated breaker is. In fact, there are no governing documents, aside from the manufacturer, which define the breaker ratings. The NEC only provides the limitation of these breakers when applied to circuits with continuous loads.

The choice between 80%- and 100%-rated breakers must start with the calculation and classification of the load on the circuit. Once the total load and calculated loads are determined, the specifier can choose the breaker current rating with the correct application rating. Specifiers must consider cost, availability, and complexity of installation when deciding between 80%- and 100%-rated circuit breakers.

The scenarios provided in this paper are meant to highlight the differences between the application of 80%- and 100%-rated breakers. There are many other selection guidelines, installation requirements, applicable codes and regulations that must be considered for different applications. Be sure to reach out to a KOHLER® distributor in your local area for assistance to determine the best breaker ratings for a project.

ABOUT THE AUTHOR

Al deLeon is a Senior Project Engineer at Kohler Energy. He holds a bachelor of science degree in electrical engineering from Marquette University. Al joined Kohler in 2022 with extensive experience in facility design as a consulting engineer for more than a decade. He has been part of engineering teams designing large industrial, commercial, and educational buildings with generator systems. He has also designed wind, hydroelectric, and solar power plants.

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