

Value Engineering: Series Rating Circuit Breakers in Panelboards

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Introduction

This paper investigates the potential for cost savings when using series rated circuit breakers instead of fully rated circuit breakers in panelboards. This paper will not discuss the rules and technical requirements for using series ratings. The reader is instead referred to the references and the National Electric Code to determine if series ratings may be used for a particular situation. Once all code requirements are verified to be satisfied for using a series rating, one may entertain the question “what is the potential cost savings by using series rated instead of fully rated panelboards?”

Lighting panels are often the single most numerous piece of electrical distribution equipment for commercial projects and provide the greatest opportunity for cost savings by using series ratings. General Electric A-Series Lighting Panels are the basis for all of the data presented here. Only series combinations using circuit breakers are considered. The cost of series rated panelboards of different voltage, amperage, and interrupt rating will be compared to the cost of the fully rated equivalents to provide some insight to the value engineering benefit of this design choice.

Series Ratings

The GE series ratings used in the examined cases are documented in GE publication DET-008. This document is available in the GE publications library and a link is provided in the references. When two breakers are said to be series rated, the upstream breaker is rated for the available fault current in the system at that breaker’s location, but the downstream breaker in the series rated pair has a lower interrupt rating than the available fault current at its location. The series rating implies that in the event of fault current beyond what the downstream breaker is rated to interrupt, the upstream breaker will always trip first and the downstream device will remain passive. The downstream device is therefore prevented from interrupting (or attempting to interrupt) a fault beyond its rating. Series rated combinations are not limited to devices in the same piece of equipment. For example, a feeder in a switchboard could be series rated with the branch devices in a main-lug-only panelboard.

Because the downstream device has a lower interrupt rating, it is less costly than an equivalent breaker with a higher interrupt rating. This cost difference is what makes a series rated panelboard generally less costly than a fully rated panelboard. In the fully rated panelboard, every breaker would have an interrupt rating above the available fault current

Cases

Table 1 lists the combinations of panelboard voltage, amperage, interrupt ratings, and main type (main circuit breaker or main lugs) used to define the various cases. The phase-to-phase voltage of the service the board is configured for is the basis for the voltage designation.

Case Number	Voltage (Vac)	Amperage (Amps)	Interrupt Rating (kA)	Main Type (MCB or MLO)
1	208	225	22	MCB
2	208	400	22	MCB
3	208	600	22	MCB
4	208	225	65	MCB
5	208	400	65	MCB
6	208	600	65	MCB
7	208	225	22	MLO
8	208	400	22	MLO
9	208	600	22	MLO
10	208	225	65	MLO
11	208	400	65	MLO
12	208	600	65	MLO
13	480	225	42	MCB
14	480	400	42	MCB
15	480	600	42	MCB
16	480	225	65	MCB
17	480	400	65	MCB
18	480	600	65	MCB
19	480	225	100	MCB
20	480	400	100	MCB
21	480	225	42	MLO
22	480	400	42	MLO
23	480	600	42	MLO
24	480	225	65	MLO
25	480	400	65	MLO
26	480	600	65	MLO
27	480	225	100	MLO
28	480	400	100	MLO
29	480	600	100	MLO

Table 1. Panelboard Configurations
(MCB = Main Circuit Breaker, MLO = Main Lug Only)

Each of the 208V cases uses an AQ panelboard configured for a 208Y/120V 3-phase 4-wire system and was populated with 42 single-pole 20A circuit breakers

branches. Each of the 480V cases uses an AD panelboard configured for a 480Y/277V 3-phase 4-wire system and was populated with 16 two-pole 20A circuit breaker branches. In all cases the panelboard consisted of only one enclosure. In general, particular combinations of board type, voltage, amperage, and interrupt rating may allow only a fully rated option or only a series rated option. One of the criteria for case selection was the availability of both a series rated and fully rated option. Where multiple series rating options existed for a given case, the lowest cost option was always used.

The A-Series AQ model panelboard is a maximum 240Vac panel that uses bolt-on breakers. The single-pole branch devices used in evaluating the cases are 10kAIC THQB, 22kAIC THHQB, or 65kAIC TXQB circuit breakers. This panelboard may be series rated at 22 kAIC or 65 kAIC. Below 22 kAIC the board is only fully rated (at 10kAIC), and above 65 kAIC the board is only series rated.

The A-Series AD panelboard is a maximum 600Vac panel commonly used for 480/277V applications. The two-pole branch devices used in evaluating the cases are 18 kAIC TED, 18 kAIC SED, 65 kAIC FBN, and 100 kAIC FBH branch circuit breakers. This panel is fully rated only at 10 kAIC and 14 kAIC. From 18 kAIC to 100 kAIC, the AD panel may be fully or series rated. The 42 kAIC, 65kAIC, and 100 kAIC ratings are included cases.

All data is based on cost information current as of October 2009 for a factory-assembled unit. The series rated combinations considered in this article are restricted to currently manufactured circuit breakers. Series ratings with obsolete devices are not considered. For example, one could series rate a new main-lug-only panelboard with an existing obsolete upstream device and possibly obtain results that differ from those below. In such renovation projects, it is especially important to contact your local GE representative to obtain costs related to your specific circumstances.

Results and Analysis

The relative cost is defined as 100 times the cost of the series rated board divided by the cost of the equivalent fully rated board. This produces a value that represents the series rated board cost as a percentage of the equivalent fully rated cost. Different cases with the same or similar relative cost do not generally equate to the same actual dollar savings since the actual cost of a board varies based on interrupt rating, amperage, and main type.

Figure 1 displays the relative cost of 208V series rated AQ panelboards for cases one through six. As expected, the cost of the series rated board is less than its fully rated equivalent in every case. The series rated panels allow cost savings of approximately 1.3% to 21.5% compared to their fully rated counterparts. The series rated boards at 65 kAIC have a lower relative cost than the series rated 22kAIC

boards. This is because the price difference between a 10kAIC and 22kAIC breaker is relatively small compared to the cost difference between a 10 kAIC and 65 kAIC breaker. The relative cost of the series rated boards increases from a 225A to a 400A board for both interrupt ratings. This is also expected because the effect of the reduced cost of series rated branch breakers on total cost is diminished as the cost of the panelboard structure and main breaker increases. This expected trend, however, is not continued comparing the 400A and 600A relative costs.

Figure 1
Main Circuit Breaker Series Rated AQ Panelboard 208Y/120V

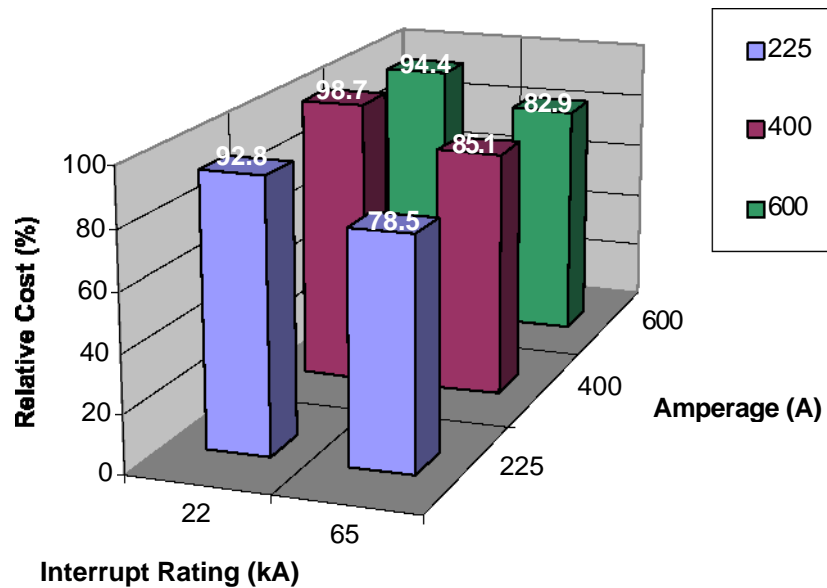


Figure 2 displays the results for the same 208V interrupt and amperage ratings, except the board uses main lugs (cases six through twelve). The upstream device of the series rated combination is not in the panelboard, and was chosen to be the same breaker as used in the main breaker cases. For the main lug only cases the relative cost savings of a series rated board range from negligible (< 1%) to almost 25%. Costs of the series rated boards at 22kAIC are again very close to their fully rated counterparts due to the small difference in price between 22 kAIC and 10kAIC branch breakers. The relative cost of the 65 kAIC boards is less for each board amperage rating compared to the main breaker boards. Without the cost of a main breaker, the difference in price between 10 kAIC and 65 kAIC branch breakers has a greater impact on the relative cost between the series rated board and its fully rated equivalent.

Figure 2
Main Lug Only Series Rated AQ Panelboard 208Y/120V

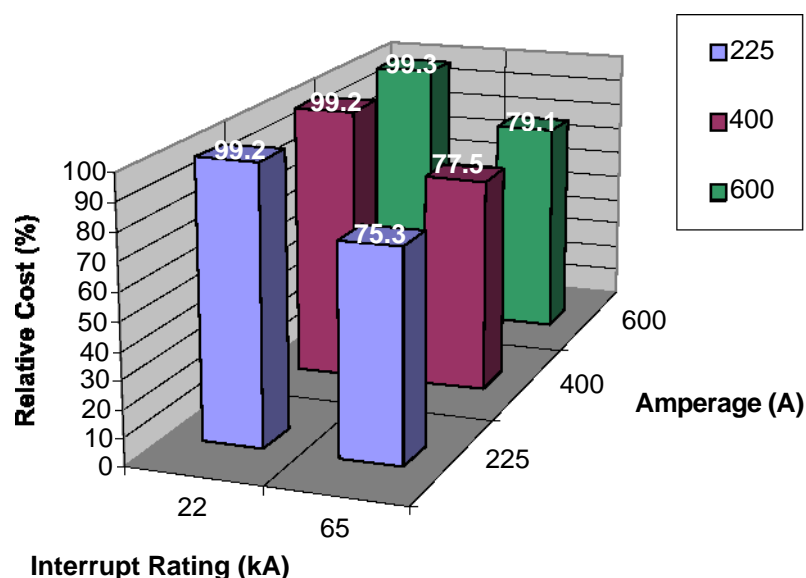


Figure 3 displays the relative cost of series rated AD panelboards with main circuit breakers (cases 13 through 20). The relative costs range from about 55% to almost 73%, suggesting possible cost savings as high as 45%. The relative costs in these cases are all less than the lowest relative cost of any of the 208V cases. This is primarily due to the fact that the 480V two-pole branch breakers are more expensive than the single-pole branch breakers used in the 208V cases. The difference in cost between the 480V fully rated branches and the series rated branches also becomes larger. Also noticeable in figure 3 is the split between relative costs below 60% and those above 70%. This is accounted for by the difference in branch breakers that were required to meet the specific set of ratings for the series rating. All 225A cases and the 400A, 42 kAIC case were able to use a thermal-magnetic TED to series rate with the main breaker. In the remaining figure 3 cases, the series rating could only be met with a more expensive electronic trip SED. With one exception, the relative cost increases with board amperage for the same reason explained in the 208V cases. No results are shown in the 600A, 100kAIC category because this is not an available rating set with a main circuit breaker AD panelboard.

Figure 4 shows the results for cases 21 through 29. Relative cost ranges from about 45% to 70%, allowing for cost savings as high as 55%. In each case the series rated relative cost is less for the MLO board compared to the MCB version in figure 3. This is again due to the influence of the main breaker's cost on the overall board cost. The trends seen in figure 3 are also apparent in figure 4. Two tiers of relative cost are observed and are again driven by the type of branch breaker used to meet the ratings. The 225A cases all have the same relative cost because the same branch breaker could be used for each of the interrupt levels.

Figure 3
Main Circuit Breaker Series Rated AD Panelboard 480Y/277V

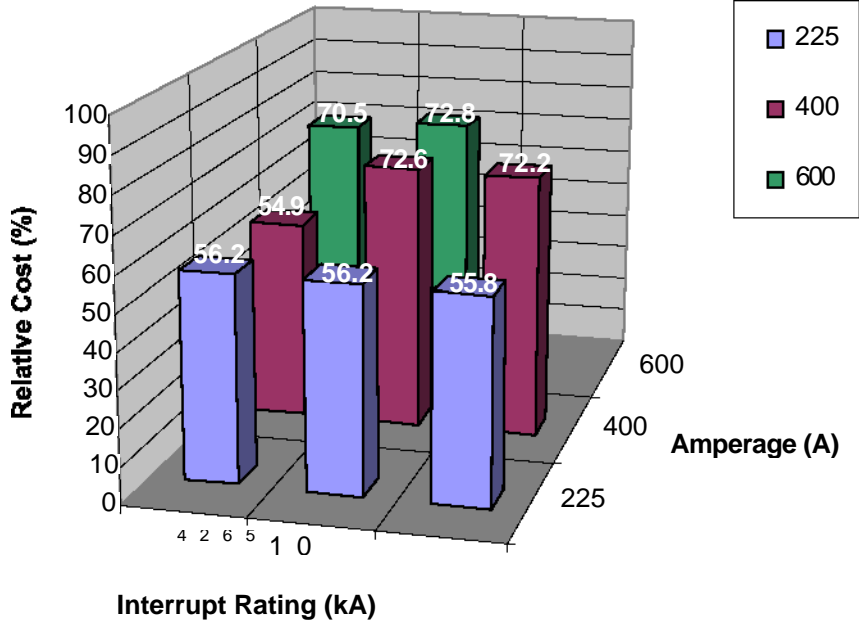
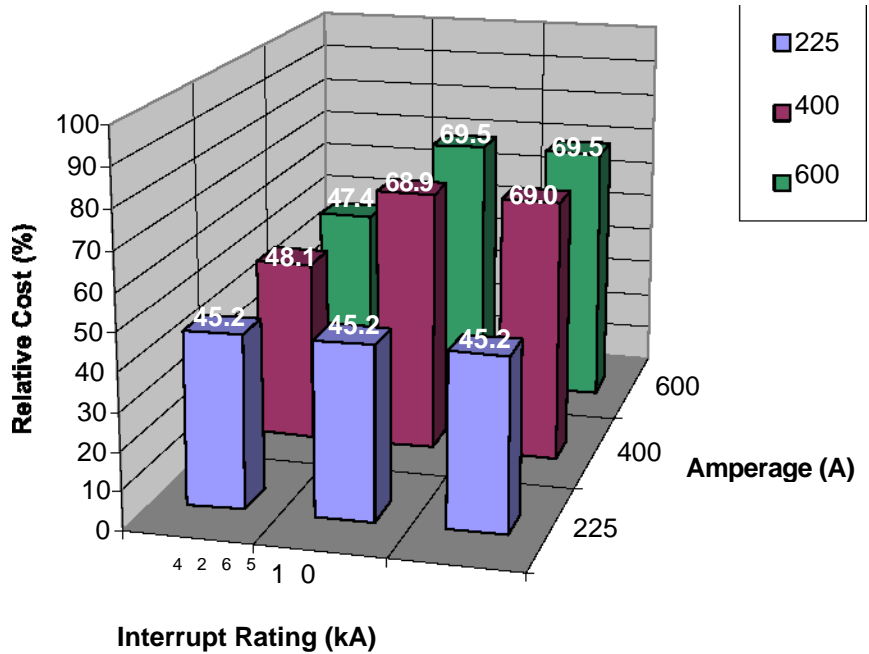


Figure 4
Main Lug Only Series Rated AD Panelboard 480Y/277V



Conclusions

The initial cost benefit of using series rated panelboards is influenced by the board voltage, amperage, and interrupt ratings, as well as the main type. For the specific cases used, a 208V series-rated panelboard cost can range from approximately 75% to over 99% of the equivalent fully rated version. The potential cost savings in these results represent the best-case savings where the board is fully populated with 20A 1P branch breakers. The cost difference between series and fully rated boards should be expected to be less for boards with fewer branch devices. At 480/277V, the cases analyzed indicate significant opportunities for cost savings, with the series rated board costing 45% to 73% as much as the fully rated equivalent.

While this article hopefully provides some useful guidelines on the potential cost benefits of series ratings, the reader is cautioned to not extrapolate the results discussed here to obtain specific cost saving projections. The reported results are specific to the ratings, panelboard types, and branch devices used. New breakers, new tested series combinations, and changes in market conditions are some of the variables that will influence even the reported results over time. The design engineer should contact their local GE representative to obtain budgetary pricing on series rated panelboards and fully rated panelboards to best assess the potential cost benefit for a particular project.

References

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