

## Series Rating: Protecting Circuit Breakers

### Example 2

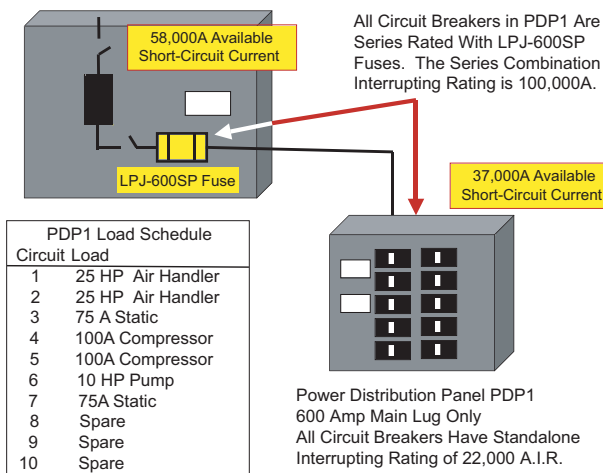
Below is an easy to use table to evaluate the “protected” (loadside) circuit breaker in a series rated combination for meeting the motor contribution limits in 240.86(C). In the Figure 7 example, the motors that are connected that could contribute current where the feeder circuit breaker (“protected” device of the series combination) would have to interrupt but that the main circuit breaker (“protecting” device of the series combination) would not have to interrupt is represented by 500A of normal full load current. Reading the table below, it is seen that 500A full load motor current exceeds 420A in column A. Therefore, a series rating with a “protected” circuit breaker having a stand-alone interrupting rating of 42,000 AIR is insufficient to meet 240.86(B). A series combination that uses a “protected” circuit breaker with a stand-alone interrupting rating of at least 50,000A would be required to meet 240.86(C). Note; do not confuse the stand-alone interrupting rating of the “protected” circuit breaker with the series combination interrupting rating. The series combination interrupting rating is the rating for both devices working together to interrupt short-circuit currents. The series combination interrupting rating is much greater than the stand-alone interrupting rating of the “protected” circuit breaker.

Motor Full Load Amps Shall Not Exceed This Value, If Using Series Combination With “Protected” Circuit Breaker Having Standalone Interrupting Rating In Column B	“Protected” Circuit Breaker Standalone Interrupting Rated In Series Combination	Motor Full Load Amps Shall Not Exceed Value If Using Series Combination With “Protected” Circuit Breaker Having Standalone Interrupting Rating In Column B	“Protected” Circuit Breaker Standalone Interrupting Rated In Series Combination
(A)	(B)*	(A)	(B)*
75A	7500 AIR	250A	25,000 AIR
100A	10,000 AIR	300A	30,000 AIR
140A	14,000 AIR	350A	35,000 AIR
180A	18,000 AIR	420A	42,000 AIR
200A	20,000 AIR	500A	50,000 AIR
220A	22,000 AIR	650A	65,000 AIR

\*Some Possible circuit breaker interrupting ratings per UL489, Table 8.1

### Example 3

Assess the series combination rating for motor contribution limits in the following system.



### Step 1: Motor Load

(2) 100A Compressors	200A
(2) 25Hp Motors @ 34A ea.	68A
(1) 10Hp Pump @ 14A	14A
Total Motor Load Connected Between Series Rated Devices	282A

### Step 2: Is the Series Rated Combination Shown Acceptable?

No. The series combination shown has a series combination interrupting rating of 100,000A, which is sufficient for the 37,000A available short-circuit current at PDP1. And the LPJ-600SP fuses have an interrupting rating of 300,000A, which is sufficient for the 58,000A available short-circuit current at the main switchboard. However, the “protected” circuit breakers of the series combination, which are located in PDP1, have a stand-alone or individual rating of 22,000A. The motor load connected between the protecting and protected devices in the series rated combination can not exceed 1% of the protected circuit breaker’s stand-alone interrupting rating. The motor load is 282A, which exceeds 1% of 22,000A (220A). So this series rated combination applied as shown does not comply with 240.86(C).

Then consider the uncertain future of building spaces. For instance, many building spaces, such as office buildings, manufacturing facilities, institutional buildings, and commercial spaces, by their nature, incur future changes. A properly designed and initially installed series combination rating could be compromised if the building loads change to a larger percentage of motor loads.

As just illustrated, it is not enough to only check the available short-circuit current against the series combination interrupting rating. 240.86(C) also requires that the designer, contractor, and AHJ investigate the individual or stand-alone interrupting rating of the protected circuit breaker of a series combination. This is necessary for series rated combinations for new installations as well as existing series rated combinations when existing systems are refurbished or upgraded.

### Selective Coordination Requirement Limitations

Inherently, series rated combinations cannot be selectively coordinated. In order to protect the loadside circuit breaker, the lineside (protecting) device must open in conjunction with the loadside (protected) circuit breaker. This means that the entire panel can lose power because the device feeding the panel must open even under relatively low-level short-circuit conditions.

Therefore, in health care facilities where selective coordination for ground faults is required per 517.17 between the main and feeders, the application of series rated combinations does not meet this requirement. Also, with the application of series rated combinations it is difficult to meet the selective coordination requirements for elevator circuits per 620.62, emergency systems per 700.27, legally required standby systems per 701.18 and healthcare essential electrical systems per 517.26. The application of series rated combinations reduces emergency circuit overall system reliability because of their inherent lack of fault current coordination. See Figure 8.