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Friday, 01 February 2008 00:00

Current limitation improves safety and reduces downtime. Dramatic improvements are possible simply by upgrading circuit protection during routine maintenance.

Increasing Safety And Reliability Using Current Limitation

Any maintenance worker will tell you that he/she would rather deal with circuit breakers than fuses. In their view, finding and resetting a breaker is faster than replacing a blown fuse, increasing the time they can devote to more pressing maintenance work.

In reality, current-limiting fuses can actually reduce downtime and increase reliability. For example, a short-circuit that stops one machine can be selectively coordinated so it has no effect on the rest of the plant, and maintenance personnel can concentrate on finding the single fault rather than checking every circuit.

Current-limiting fuses and breakers also improve reliability by limiting the potential energy of an Arc-Flash and increasing short-circuit current ratings (SCCR) of industrial control panels. Electricity can be amazingly destructive, leading to explosion, fire, melted wires and shattered components. If equipment is damaged from a destructive fault or Arc-Flash, significant downtime may follow until the equipment is repaired or replaced. Moreover, if there is a serious electrical accident, a manufacturing plant can remain closed for days, or even months, before

normal operations can resume.

Current-limiting devices are easily retrofitted into existing electrical systems. The job can be handled as part of normal maintenance or when a fault must be cleared, and it may be as easy as upgrading the fuse. Although current-limiting circuit breakers exist, they are more expensive and not as readily available as the current-limiting fuses on which this article focuses.

Current limitation defined

According to Article 240.2 of the National Electrical Code (NEC), a current-limiting overcurrent protective device reduces the current flowing in a faulted circuit to a level significantly less than the current that could flow if the device were not present. This essentially means that the current-limiting device opens and clears the fault (shortcircuit) within the first half cycle of a fault. UL Listed current-limiting fuses must open and clear a fault within 8.3 msec after fault initiation.

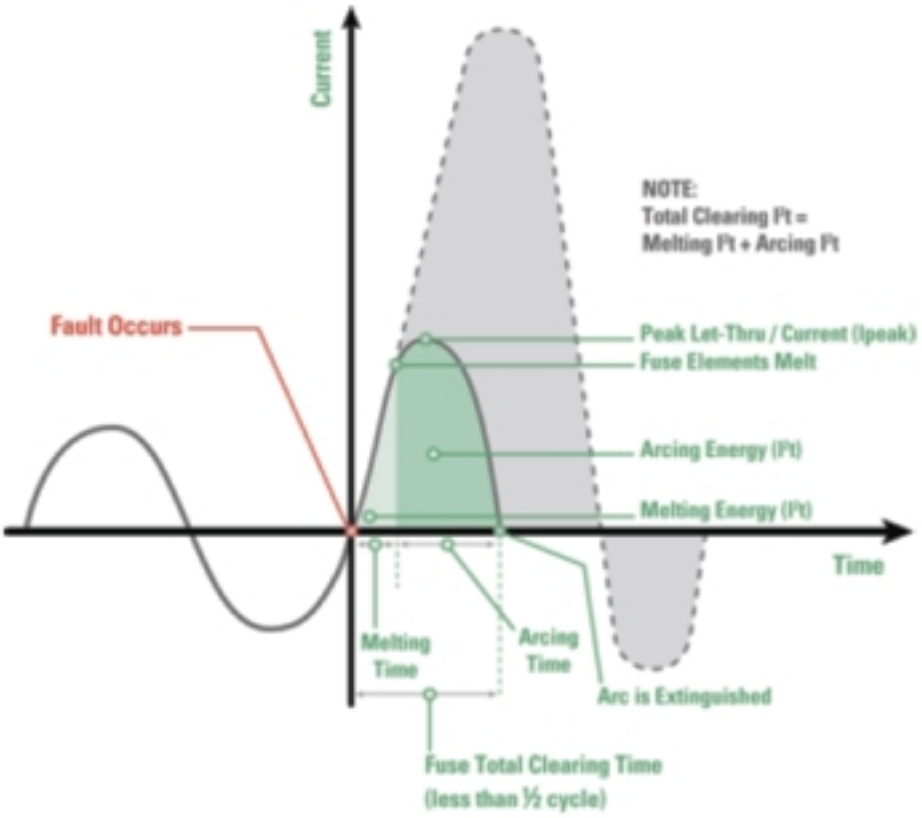

Fig. 1. Current-limiting fuses reduce peak current and clear the circuit in 8.3 msec or less, significantly reducing Let-Thru energy in the circuit.

The effect of a current-limiting fuse in a circuit is illustrated in Fig. 1. With no current-limiting device in the circuit, the instantaneous peak current during the first half cycle after a fault can be as high as 2.3 times the available rms bolted fault current available at the equipment. For example, if the available rms fault current at an industrial control panel is 100,000 A, the maximum possible instantaneous peak current could be as high as 233,000A. However, with a

current-limiting fuse in the circuit, the instantaneous peak current reaches only a small fraction of the maximum possible current at the equipment. A current-limiting fuse not only reduces peak current, it also clears the circuit in 8.3 msec or less.

The area under the curve, or I^2t, is the energy released during a fault. The lower the I^2t, the lower the destructive forces. Therefore, by minimizing both fault duration and energy released, current-limiting fuses greatly minimize Arc-Flash and Arc-Blast hazards. In addition, currentlimiting fuses significantly reduce Let-Thru energy in the circuit. (Let-Thru energy produces heating and magnetic effects associated with short circuits.)

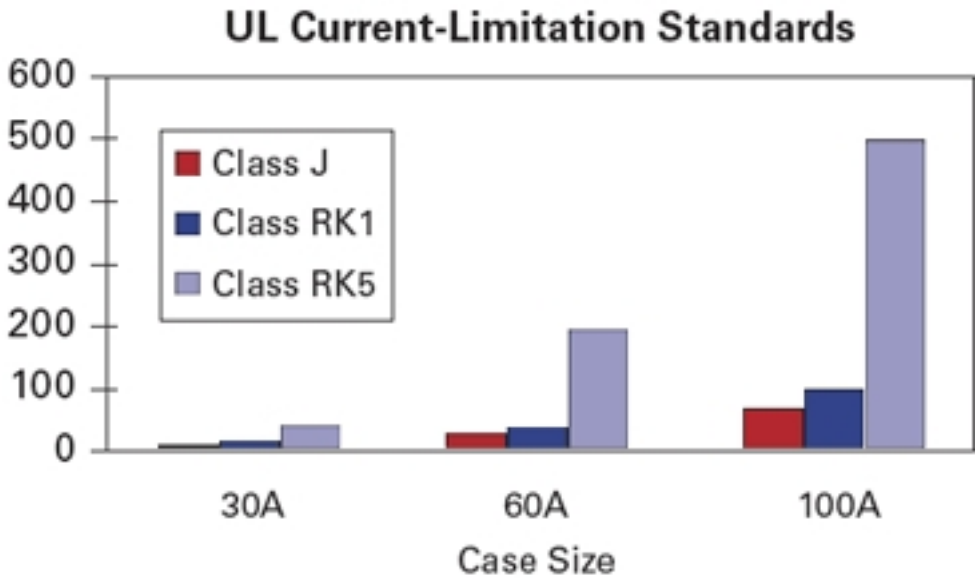

Fig. 2. UL Listed current-limiting fuses must pass a series of short-circuit tests and limit I^2t energy to the maximum values shown here.

UL Listed current-limiting fuses must pass a series of short-circuit tests and limit the I^2t energy to the maximum values shown in Fig. 2. UL class RK1 fuses have much lower I^2t values than UL class RK5. UL class J fuses have even lower maximum values and are sized differently so that they cannot be interchanged with something less current limiting. It is important to note that although these are maximum limits imposed by UL, actual I^2t values and Peak Let-Thru currents are generally much lower and vary from one manufacturer to another.

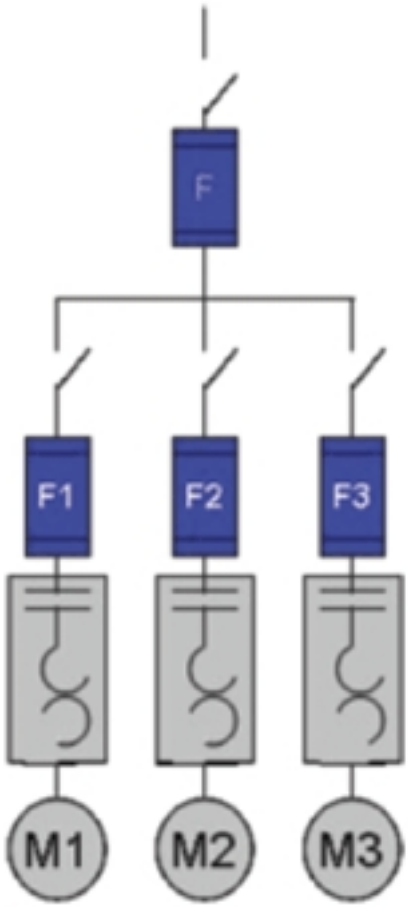

Fig. 3. Diagram of a simple selectively coordinated system

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