Reduce Arc Flash Energies by Upgrading to A6D Class RK-1 Fuses

Tech Topics:
Arc Flash
Note 4, Issue 1

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Points of Interest:

- A6D Class RK1 fuses have lower let-through energies and lower current limiting thresholds
- I't a key value for evaluating performance of energy limitation
- Upgrading to the A6D is a simple replacement of UL Class RK5, K or H fuses

A6D has Superior Current Limitation

Arc flash incident energies can often be significantly reduced by simply replacing UL Class RK5, Class K, and Class H fuses with A6D UL Class RK1 fuses. This is an easy and inexpensive solution, since the A6D fuses fits into the same fuse holders. Please note that Class H fuses are not current limiting and have a very low interrupting rating. If there are any of these left in your system you should plan to retire these as soon as safely possible.

Upgrading to A6D Class RK1 fuses can reduce arc flash energies because these fuses have lower let-through energies in their current limiting range and lower current limiting thresholds. The superior current limiting ability of RK1 fuses is illustrated in Figure 1. The RK1 fuses are compared to the RK-5 fuses, the next closest in current limiting ability. Note that under similar circuit conditions an RK-5 fuse of the same ampere rating can allow the let-through current to reach peak instantaneous values (Ip) twice that of the RK1 fuse as shown in Figure 1.

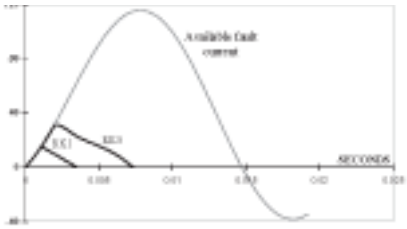

Figure 1: Ip Comparison

This reduction in current translates into much larger reductions in electrical energy delivered to the fault. Table 1 shows a comparison of fuse I^2t let-through energies for a 50,000A available fault current. The fuse I^2t limits are from the UL 248 standards. The value for the 1/2 cycle clearing time has been calculated for a symmetrical fault. Compared to the RK1, the I^2t energy of a RK-5 fuse can be up to 5 times higher. The I^2t of the RK1 can be less than 1% of a full 1/2 cycle. A6D fuses have even better performance than the values shown here for Class RK1.

Size	RK-1	RK-5	1/2 Cycle
30A	10,000	50,000	20,833,333
80A	40,000	200,000	20,833,333
100A	100,000	500,000	20,833,333
200A	400,000	1,600,000	20,833,333
400A	1,200,000	5,000,000	20,833,333
600A	3,000,000	10,000,000	20,833,333

Table 1: Comparison of UL248 A^2s limits for an available fault currrent of 50,000A

Figure 2, from Select-A-Fuse© software shows the difference in time current curves for the A6D400R (RK1) and the TRS400R (RK-5). Notice that for a fault current of 8,500A, the TRS400R will take 1-2 cycles to clear, while the

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A6D400R curve is less than 0.01 seconds because it is current limiting at this current level. This is due to the lower current limiting threshold. For more information on current limitation see Arc Flash Note 2. The examples on the next two pages illustrate how upgrading a Class RK5 fuse to Mersen's Amp- Trap 2000® A6D Class RK1 fuse can dramatically reduce arc flash energies.

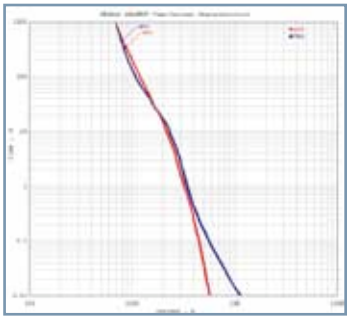

Figure 2: Comparison of Time Current Curves for TRS400R (in Blue) and A6D400R (in Red)

Example 1

Situation In the application represented in Figure 3, a main lug only panel fed by a 480V feeder is protected by a TRS600R Class RK5 fuse. The short circuit study predicts an available fault current of 19,800A at the line terminals of the panel. For an incident energy calculation, you must use the characteristics of the upstream overcurrent protective device for the available fault current at the panel.

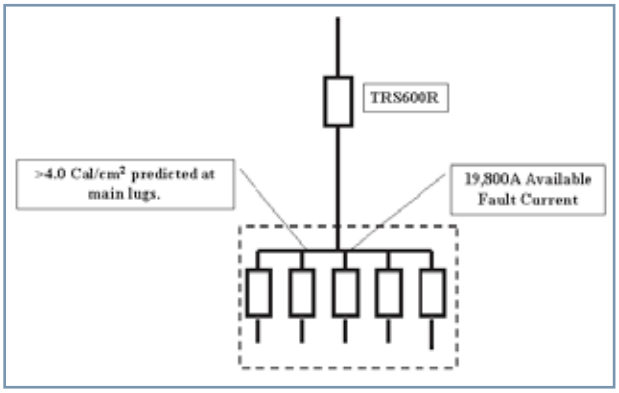

Figure 3: One-line diagram

Tests in Mersen's high power lab have shown incident energies at 18 inches to be in excess of 4 cal/cm² at the line terminals for this available fault current. Analysis using equations from NFPA 70E and IEEE Std 1584™ - 2002 IEEE Guide for Performing Arc-Flash Hazard Calculations yield comparable values. If a worker were to access this panel in an energized state, they would need to be protected with at least category 2 PPE.

Recommendation

To effectively reduce the arc flash incident energy in this scenario, we suggest replacing the TRS600R Class RK5 fuse with Mersen's A6D600R Class RK1 fuse as shown in Figure 4.

As Figure 5 illustrates, the A6D600R Class RK1 fuse will reduce the anticipated incident energy - under the same conditions - to approximately 0.3 cal/ cm². With its superior current limitation and a lower current limiting threshold, the 600A Class RK1 current limiting fuse dramatically reduces the expected arc fault incident energy.

The PPE requirements for workers needing to access this panel in an energized state would be reduced from Category 2 to Category 0.

The dramatic reduction in incident energy in this case greatly reduces the probability of a worker being injured. No special adapter hardware is required for this solution since the dimensions of the RK1 are identical to that of the RK5. The nominal cost of this upgrade makes it an excellent investment in worker safety.

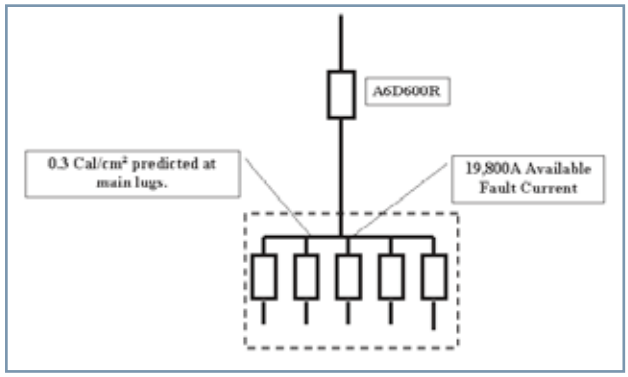

Figure 4: Revised one-line diagram

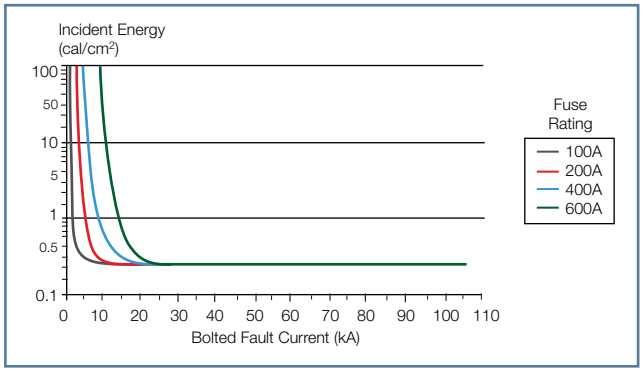

Figure 5: Incident energy chart for A6D Fuses.

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Example

Situation 2 In the application represented in Figure 6, a control panel is fed by a 480V feeder, which is protected by a 1200A circuit breaker. The panel's main fuses are 400A Class RK5 fuses. A short time delay of 6 cycles has been selected for the circuit breaker to coordinate its trip characteristics with the largest fuses in the panel (see Figure 7). The short circuit study predicts an available fault current of 28.8 kA at the line terminals of the panel. For an incident energy calculation, you must use the characteristics of the upstream overcurrent protective

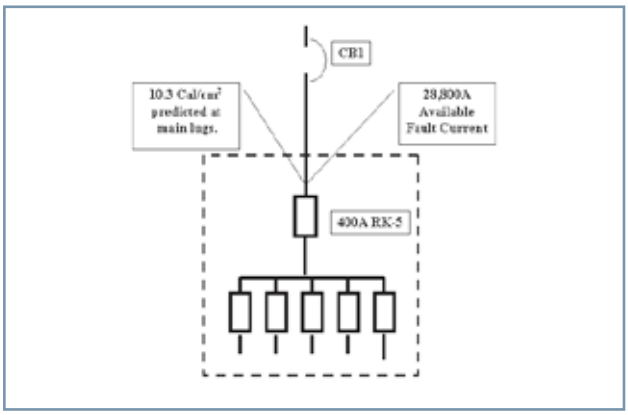

Figure 6: One-line diagram

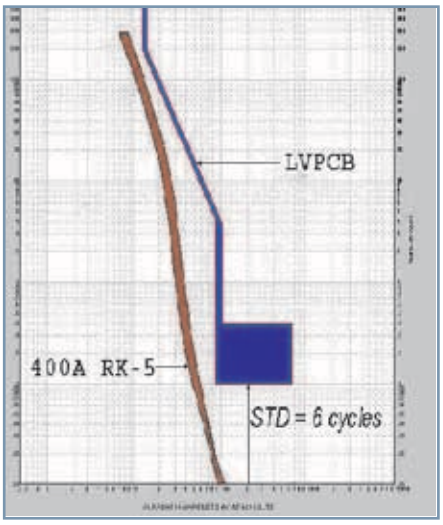

Figure 7: Plot from ESA's EasyPower® Software

device for the available fault current at the panel. The calculated incident energy at the line terminals of the panel would be approximately 10.2 cal/cm² for a working distanceof 18 inches for 28.8 kA available fault current using equations from IEEE 1584™. If a worker were to access this panel in an energized state, that worker would need to be outfitted with PPE rated for Hazard / Risk Category 3 per NFPA 70E.

Recommendation

To effectively reduce the arc flash incident energy in this scenario, we suggest replacing the 400A Class RK5 fuse with Mersen's A6D400R Class RK1 fuse and eliminating the 6 cycle delay of the upstream circuit breaker. As illustrated on page 1, the lower current limiting threshold of the A6D fuse results in a time current characteristic with the lower part of the curve to the left of the Class RK5 fuse. Figure 8 shows how the time current characteristic of the A6D400R Class RK1 fuse allows for coordination with the upstream circuit breaker with the short time delay removed. Recalculating with the new total clearing time of the breaker yields a predicted incident energy of approximately 2.9 cal/cm². The PPE requirements for workers needing to access this panel in an energized state would be reduced from Category 3 to Category 1. The reduction in clearing time also reduces the flash protection boundary from 65 inches to 30 inches.

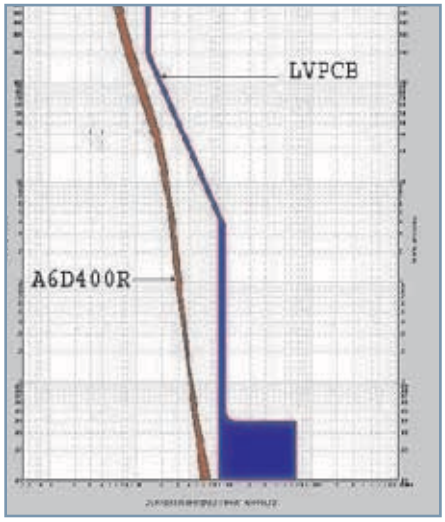

Figure 8: Plot from ESA's EasyPower® Software

No special adapter hardware is required for this solution since the dimensions of the RK1 are identical to that of the RK5. The nominal cost of this upgrade makes it an excellent investment in worker safety.

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Amp-Trap 2000® A6D Class RK1 Fuse

The best choice for upgrading existing applications of 600 amps and less, the A6D offers excellent current limiting performance for short circuits and time delay for overloads. Its dimensions allow for simple upgrades of existing Class H, Class K and Class RK5 fuses.

Best degree of arc energy mitigation. When it comes to low current limiting thresholds and low let-through energies, there is no better alternative than the A6D. When applied so that the fuses will be current limiting for arc fault currents, incident energy at working distances of 18" are typically less than 0.25 cal/cm^2.

Easy upgrade to Class RK1 protection. This simple change can dramatically reduce incident energies for workers exposed to energized equipment. Upgrading is easy because Class RK1 fuses have the same overall dimensions as Class RK5, Class K and Class H fuses. See Figure 9. The rejection blades and ferrules of the RK classes will fit directly into the non-rejection blocks that accept Class K and H fuses. To ensure that RK1 fuses are not replaced with RK5 (or lesser) fuses, look to our inventory analysis and upgrade services. By streamlining and upgrading your inventory and training workers in circuit protection safety, you can help prevent replacement errors from occurring.

Figure 9:
A6D-R® pictured above can replace Class H, K & RK-5 fuses.

Easier system coordination.

With Amp-Trap 2000 fuses, selective coordination is ensured by maintaining a 2:1 ratio between upstream and downstream ampere ratings.

Type "2" protection for motor starters. The A6D has been certified by starter manufacturers to provide Type "2" No-Damage short circuit protection for NEMA starters.

Reliable performance. The A6D's time-delay feature (for overloads) and short circuit design allow temporary low-level overcurrents like inrush currents and motor starting currents to pass without unnecessary openings.

Additional Resources - Tech Topics

- Arc Flash Note 1: Multiple Hazards of Arcing Faults (part no. TT-AFN1)
- Arc Flash Note 2: Reducing Arc Energies with Current-limiting Fuses (part no. TT-AFN2)
- Arc Flash Note 3: Arc Flash Hazard Analysis is Required (part no. TT-AFN3)
- Arc Flash Note 4: Reduce Arc Flash Energy by Upgrading to Class RK1 Fuses (part no. TT-AFN4)
- Component Protection Note 2: Enhancing Short Circuit Safety with Type 2 Protection of Motor Starters (part no. TT-CPN2)

Other Application Literature & Resources

- Type 2 Motor Starter Protection Fuse Selection Guide
- Amp-Trap 2000 Brochure (part no. BR-AT2000)
- Advisor: Selectivity Between Fuses (See Application Section)
- Arc Flash Info Center

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