STANDARDIZING ON ATDR UL CLASS CC FUSES FOR REPLACEMENTS

APPLICATION NOTE: AMP-TRAP 2000®
NOTE 1

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INTRODUCTION

When a fuse opens to protect a piece of equipment, maintenance personnel come under pressure to get the equipment back up and running. In addition to troubleshooting and repair, the electrician must ensure that the replacement fuse provides equal (or better) protection. The wide variety of midget fuses with a range of ratings often times leads to replacements with potential safety issues. The safety issues related to inadequate ratings does not typically manifest itself until the replacement fuse is called upon to operate.

Many Maintenance Repair Organizations (MROs) have elected to standardize on the ATDR class CC fuse (Figure 1) as a replacement for all supplemental 'Midget' fuses. Since their ratings are always equal to or better than midget fuses, replacement with a class CC fuse ensures that the next fuse opening will be safe.

Figure 1

BACKGROUND

Supplemental Fuses and Branch Circuit Fuses

Fuses UL listed for Branch Circuit Protection have a class designation such as Class J, RK, CC, L and T. These fuses are acceptable for compliance with the NEC requirements for overcurrent protection. The standards for these fuses may have stricter requirements than a supplemental fuse. For example, branch circuit fuses are constructed so that substitution by a fuse with a lower interrupting rating is not possible without modification to the equipment. The 'rejection' features used for this can be physical size differences or a mechanical feature. See Figure 2. The rejection feature on the bottom ferrule of the Class RK1 fuse (orange) prevents the Class H fuse (on the left) from being installed in a RK1 fuse holder. The smaller 250V fuses at top do not fit in the 600V fuse holder.

A supplemental fuse is intended for the protection of equipment outside the requirements of the NEC for branch circuit protection. Equipment manufacturers can select a supplemental fuse based upon the intended application of their product.

Figure 2

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The ATDR Class CC fuse is shown adjacent to several supplementary midget fuses in Figure 3. ‘Midget’ fuse is a general trade term used to refer to fuses up to 30A that have a body size of 1-1/2" long by 13/32" diameter. The Class CC fuse is physically differentiated from the Midget fuse by the tab on one ferrule. This tab is part of a mechanical rejection system that prevents the insertion of the a Midget fuse into a UL class CC fuse block. However the UL class CC fuse can easily be inserted into a standard midget fuse block so as to improve protection.

RATINGS TO CONSIDER WHEN REPLACING A FUSE

To ensure that a safe replacement fuse is chosen, the following ratings and information on the fuse label must be considered. Where appropriate the advantage of the class CC fuse will be identified.

Ampere Rating. For supplemental fuse applications, the equipment manufacturer’s recommendation for maximum ampere rating should be followed. For branch circuit protection applications, the NEC requirements should be followed. The general philosophy of the NEC is to have the ampere rating equal to ampacity of the circuit. However there are exceptions to this, such as motor circuits. Article 430 allows a larger fuse ampere rating if an overload relay is properly applied.

Ampere interrupting rating (AIR). Article 110.9 of the NEC requires that the ampere interrupting rating of a overcurrent protective device is greater then the fault current available at the terminals of the equipment protected. Interruption of fault currents greater than the AIR can lead to catastrophic failure of the overcurrent protective device and damage to the equipment.

- Ampere interrupting ratings (AIR) for Midget supplementary fuses can range from 100,000A to as low as 750A. Care should always be taken to ensure that the interrupting rating on the label of the fuse being installed is greater than the available fault current.
- The 200,000A Interrupting Rating (200kAIR) of the ATDR Class CC fuse ensures that this NEC requirement is easily met with every fuse replacement.

Voltage Rating. The voltage rating of the protective device should always be equal to or greater than the maximum operating voltage of the circuit being protected. During normal operations there is near 0V across the fuse. However, when the fuse is exposed to an overcurrent, the fuse element will melt and the voltage across the fuse will quickly increase to a value equal to or greater than the source voltage. If the system voltage is greater than the voltage rating, the fuse can fail catastrophically during opening and cause damage to the equipment where it is located.

- The allowable AC Voltage Ratings for midget supplementary fuses include 32 V; 125 V; 250V; 500 V and 600 V. Also note that for some supplementary fuse types, the voltage rating is not the same for all ampere ratings. Care should always be taken to ensure that during replacement the voltage rating on the label of the fuse is greater than the maximum system voltage.
- The 600V Rating of the ATDR Class CC fuse ensures that this requirement is easily met with every fuse replacement.

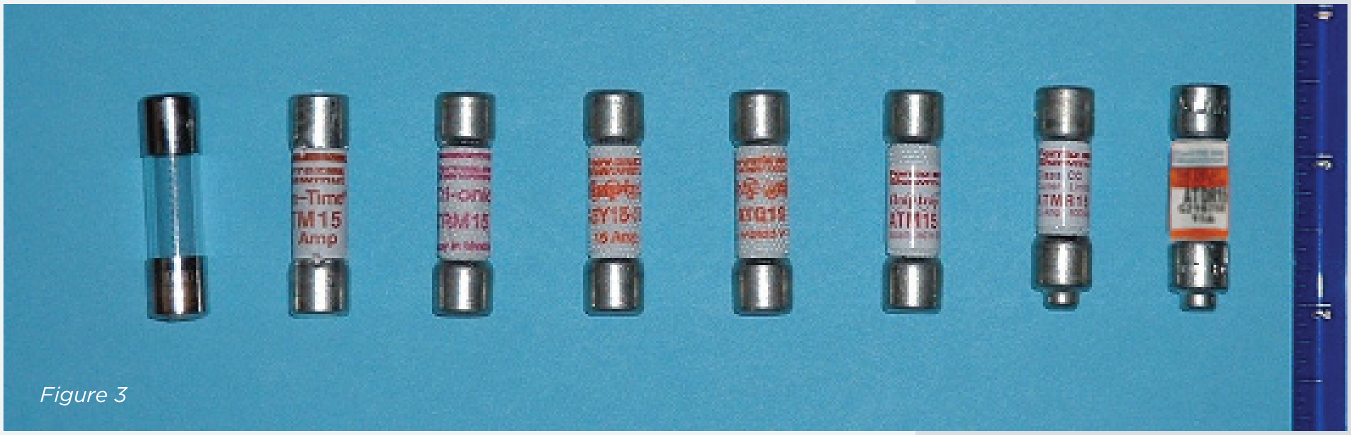

Figure 3

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Current Limiting. One of the greatest advantages of modern-day fuses is their current limiting ability (refer to Figure 4). For a UL listed fuse to be labeled current limiting, it must be capable of clearing fault level currents in less than one half cycle (8.3ms). Additionally it must begin to melt before the current's first peak. The limited current waveform shown in the figure results in dramatically reduced energy delivered into the fault.

Since the damage to equipment due to short circuits is highly correlated with the energy delivered into the fault, downtime after a fault on a circuit protected by an ATDR UL Class CC fuse is minimized. Replacement of supplementary fuses with ATDR Class CC fuse will result in enhanced short circuit protection for faults above fuse current limiting threshold. For more information see for example [1]

There are several short circuit tests in the UL 248 standards that define current limiting performance over its entire interrupting range. Supplementary fuse standards do not have these tests and as such are not labeled current limiting.

Time Delay. When it comes to overload protection of the circuit (less than the current limiting threshold of the fuse), it is important to consider not only permanent overloads but also temporary overloads. The purpose of the optional time delay feature of fuses is to minimize nuisance openings that can occur with currents that could be considered temporary overloads.

Motor circuits provide a good example of this. The ampacity of the motor circuit fuse has typically been selected to be near 125% of the full load ampere rating of the motor. Consider first a locked rotor condition. Depending on the ratings of the motor, current through the circuit can approach values of 600% or more of the full load amps. The protection must clear the circuit before the insulation in the circuit is damaged or destroyed. An example of a temporary overload would be the starting of the motor. In this case current could initially reach near locked rotor amps but would decline to the normal running current as the motor comes up to speed.

Time delay requirements for some fuse classes (e.g. Class J) are written to very easily accommodate this situation. However for class CC fuses (and midget supplementary fuses) intended for protection of control circuits, the time delay requirement of holding 200% of the fuses ampere rating for 12s does not provide as much relief for starting currents in a typical motor circuit. Recognizing this, the NEC allows for sizing all Class CC fuses for motor circuits as Nontime Delay Fuses. See Table 430.52 Note 1 in the NEC. [2]

Examination of the time current curves in Figure 5 shows that most midget fuses come close to meeting the 200% time delay requirement. Note that all fuses will clear overloads in times less than the those indicated on the cable intermediate damage curve. The ATDR Class CC fuse provides better accommodation of temporary overloads and faster operation for higher level fault currents

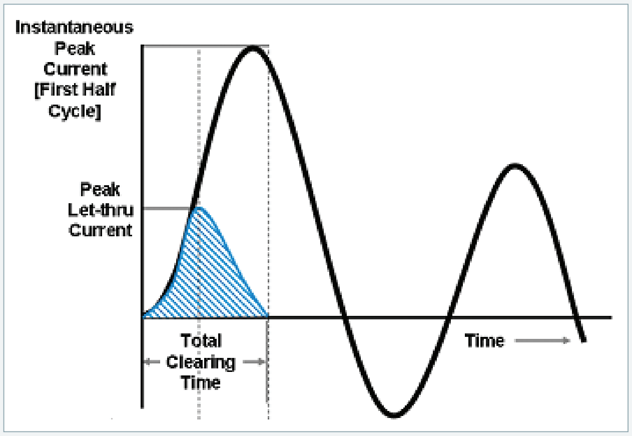

Figure 4

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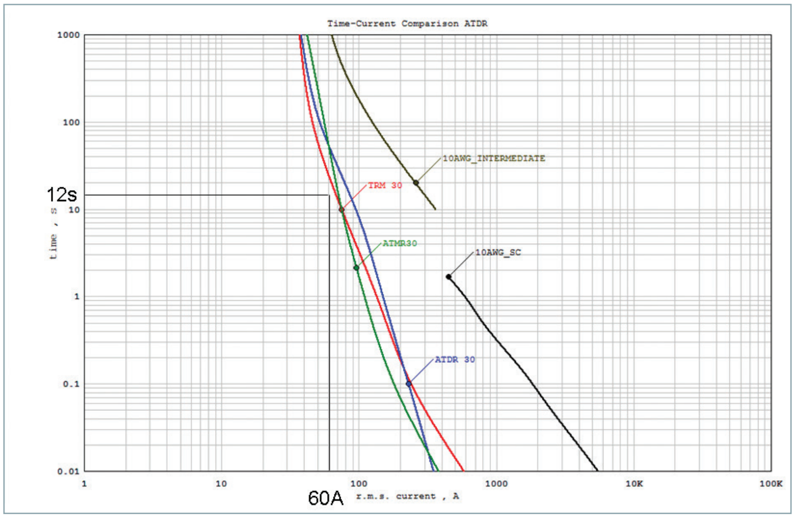

Figure 5

DC ratings. These ratings are optional for midget supplemental fuses and class CC branch circuit fuses. If the fuse is DC rated, the DC voltage rating and DC AIR must also be on the label. Typically the DC ratings will be lower than the AC ratings. Although not on the label, one must consider the L/R ratio (DC Time Constant) of the source at which the fuse was tested.

The ATDR Class CC fuse has a DC Voltage Rating of 300VDC and DC AIR of 100,000 ADC. With a test L/R ratio of 10ms, the ATDR is applicable for most DC control voltages. For higher DC voltages or DC application questions, consult Technical Services.

UL listing. The ATDR Class CC fuse is listed to UL 248-4 and has the ratings as shown in Table 1 below. The ratings for the fuses shown in the previous photo are also shown in the table below for comparison. These Midget fuses are listed to UL 248-14 for supplemental fuses.

Note that the ATDR Class CC fuse is listed for branch circuit protection and is appropriate for all applications covered by the NEC. The supplemental fuses are not.

ECONOMIC CONSIDERATIONS

There are several factors that impact an economic assessment of a consolidation to the ATDR UL Class CC fuse. To properly evaluate the economic impact both a price impact and a cost impact should be done.

Price Impact. When evaluating the price impact of consolidating to the ATDR fuse, the expected annual usage of the old fuses needs to be considered. Typically, the past 12 months usage is used for this comparison. In this case, the total price of purchases of the replaced fuses (using the past 12 months usage) would be compared with the total purchase price of the ATDR using the sum of the quantities of the replaced fuses. As an example, see the price impact of converting the four 10A fuses in the right column of Table 2 with the ATDR10. The type of fuses replaced, quantity used and contract prices will impact the bottom line total.

Cost Impact. Doing a simple price comparison fails to capture the entire economic impact. An inventory

	OTM	TRM	ATQ	A6Y-2	ATM	ATMR	ATDR
Ampere Rating	Limited	All	All	Limited	All	All	All
Voltage Rating	250V	250V	500V	600V	600V	600V	600V
AIR	10,000	10,000	10,000	10,000	100,000	200,000	200,000
Current Limiting	No	No	No	No	No	Yes	Yes
Time Delay	No	No	Yes	Yes	No	No	Yes
U/L Class	-	-	-	-	-	CC	CC
Branch Circuit Fuse	No	No	No	No	No	Yes	Yes

Table 1

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cost analysis using company defined techniques is necessary to quantify the savings of bin reduction. There are a wide variety of rules to capture the overhead costs associated with maintaining a line item of inventory. For example, for those companies using a fixed dollar amount of $100 per line item, the accounting cost savings here would be $300 for the reduction of of 3 line items.

For other methods, a new inventory level would need to be set for the ATDR10 based on previous usage of the replaced fuses. In the example above, the customer had a MAX quantity of 20 set for each of the replaced fuse bins. With one fuse, ATDR10, a MAX of 30 was chosen, thus reducing the amount of inventory - while having more spares on hand for all the applications covered by these fuses. The change in the value of the inventory could then be used in a cost impact analysis.

There are other intangible costs associated with risk (likelihood of occurrence) and as such will be based upon individual judgment. Depending on a plants situation these factors may have different levels of importance. Such factors may include:

- The potential safety issues mentioned above.
- Level training of workers who replace fuses.
- Cost of a stock out of a low usage fuse.
- Less downtime due to lower energy let through into faults.

SUMMARY

Consolidating Midget fuses to ATDR Class CC fuses offers a simplicity that provides a higher level of safety while reducing the total cost of ownership. Current replacement practices, level of training, types of spares and economics should be assessed prior to deciding if this move is right for your facility. A move to consolidation should follow a 5S process to ensure the adequacy of the inventory, database and training of the workers. [3]

REFERENCES

1. Mersen Tech Topic, "Component Protection Note 2, Enhancing Short Circuit Safety With Type 2 Protection Of Motor Branch Circuits."
2. NEC 2014
3. Mersen Fuse Control Brochure

PRICE OF ATDR USING EQUIVALENT QUANTITIES			
FUSE	PRICE	QUANTITY	TOTAL
ATDR10	$7.81	50	$390.50
TOTALS		50	**$390.50**

Table 2

FUSES TO BE REPLACED			
FUSE	PRICE	QUANTITY	TOTAL
ATQ10	$7.39	12	$88.68
ATM10	$6.17	17	$104.89
ATDR10	$7.81	18	$140.58
TRM10	$2.57	3	$7.71
TOTALS		50	**$341.86**

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