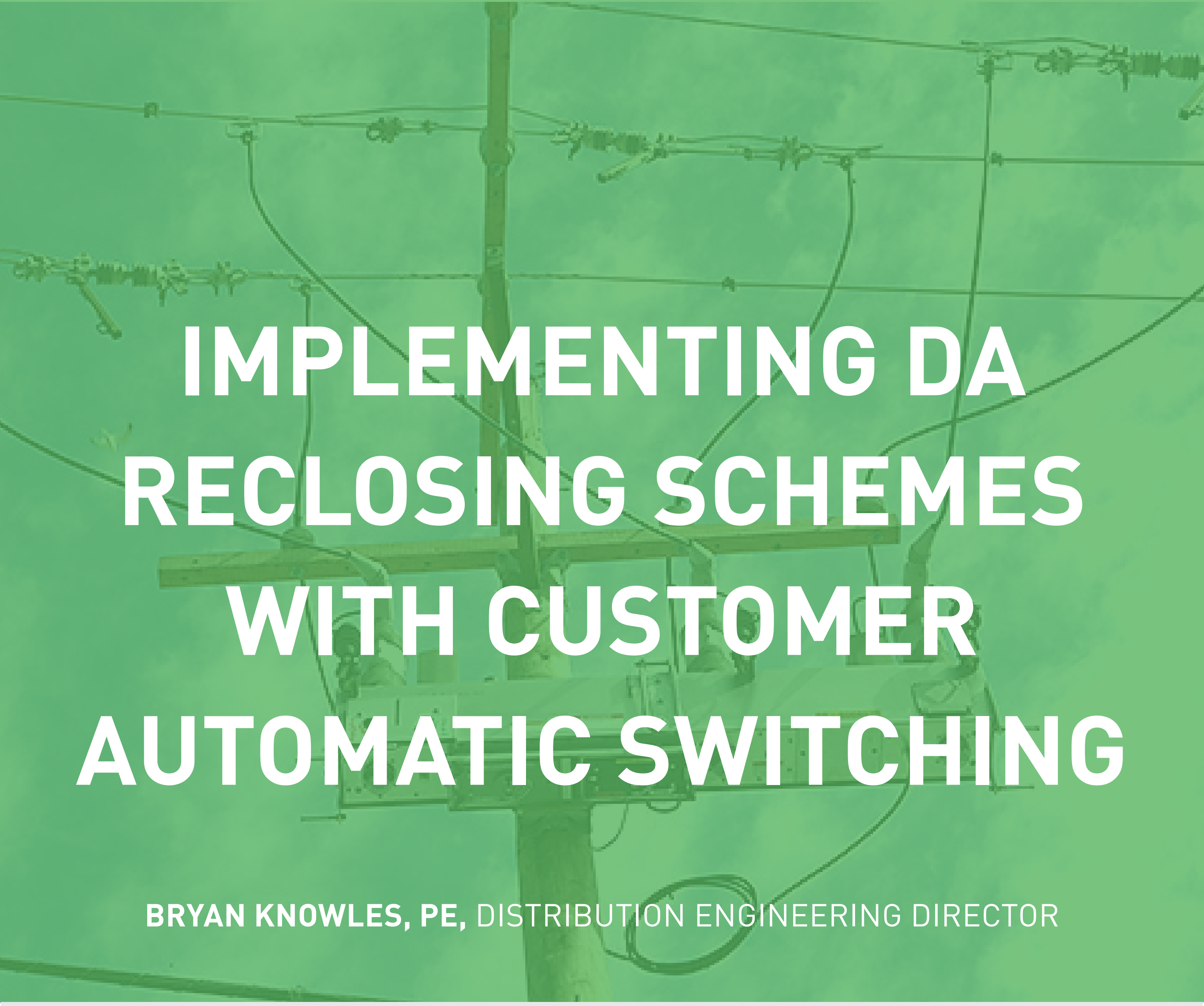

IMPLEMENTING DA RECLOSING SCHEMES WITH CUSTOMER AUTOMATIC SWITCHING

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Distribution Feeder reclosing has grown rapidly and more complex with the emergence of Distribution Automation (DA) as a method for improving customer reliability. With both substation circuit breakers utilizing reclosing, and standalone reclosers along the distribution circuits, a growing number of customers are fed from sources with auto-reclosing schemes. In the event of a loss of power on a utility feed, many customers with critical loads rely on automatic switching to restore power quickly and efficiently. There are instances where the DA scheme and the customer's existing equipment's Automatic Throw Over (ATO) do not coordinate, resulting in unnecessary switching operations. The analysis presented here aims to discuss the numerous ways to adjust either the customer's or the utility's equipment to regain proper coordination.

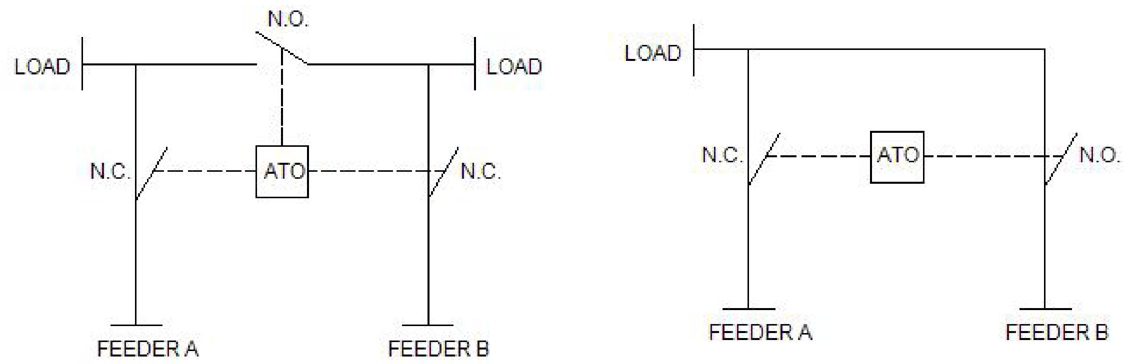

Figure 1. Typical ATO Configurations

I. INTRODUCTION

The use of feeder auto-reclosing on the distribution system is intended to clear momentary faults that occur along the system. By doing so, utilities can clear a momentary fault and restore power to their customers with just a small interruption in power. This has been taken a step further with the implementation of Distribution Automation Schemes that rely on reclosers installed along the distribution feeder with communication links. This has allowed utilities to use reclosing devices to clear momentary faults while at the same time redistributing the power when a non-momentary fault occurs. When fully implemented, the number of customers affected by a fault is greatly reduced. With a greater focus on CAIDI and SAIFI metrics, the use of DA has become a priority for many utilities.

Many large-scale customers whom receive electricity at distribution voltages 4kV and higher have onsite automatic switching that can transfer site power to additional feeders. The typical arrangements consist of either two buses fed from separate sources with a bus tie between the two, or a single bus with a normal and emergency line. In instances where the need to restore power is critical, the switches can be operated automatically via relay scheme that is designed to transfer power from one source to a secondary source. When power returns, the scheme is designed to restore power back to normal. Figure 1 illustrates two typical ATO installations.

Coordination between the customer switching scheme, commonly referred to as an Automatic Throw Over (ATO), and the reclosing scheme, is necessary to prevent unintended switching operations and repeated loss of power. Considering the customer's equipment and modifying the relay scheme, or adding additional equipment on the side of the utility, can help to minimize undue stress when modernizing the electric supply. There is no single answer suitable for each customer and utility; the following options can be utilized to create the proper coordination.

II. RECLOSING AND ATO OVERVIEW

To clear momentary faults, established clearing times are built in to the programming of these devices to allow the momentary fault to stop. Once a fault is detected, these devices will open their contacts and allow a preset time to pass before closing back in. If the fault is still detected, the same process is repeated with the number of attempts and clear times varying. One typical installation could

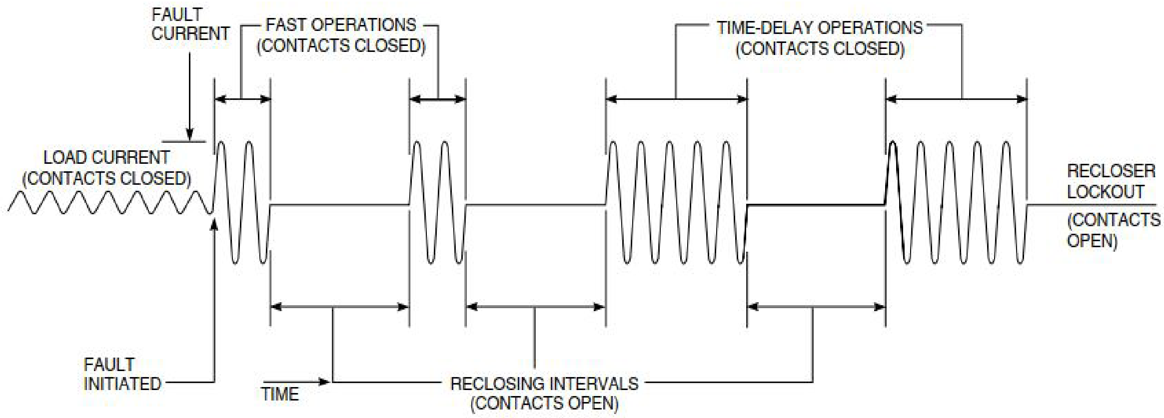

Figure 2: Typical Recloser Sequence

have a clearing time of two seconds for the first two clear intervals with the fault clearing time set to be faster than more traditional feeder fuses. This allows momentary faults to clear without causing an operation on downstream protection devices. Once these first two intervals have completed their operation, the recloser will then allow a longer time to clear the fault. This allows any downstream devices adequate time to operate, and the clear time is increased to 30 seconds. While the sequence and durations can change, this is the sequence that is utilized for the analysis in this paper. Figure 2 shows a recloser operating sequence when a non-momentary fault occurs.

The time it takes the ATO to detect a loss of power and switch to a secondary source can be less than the clear time of a recloser. The issue arises when the power is restored during the recloser operations, as the ATO will detect the power restore and begin to go back to normal conditions. If this occurs while the recloser goes through its operations, the ATO will switch over multiple times during an event instead of switching to a secondary source and staying on it until the recloser goes through its routine. This causes issues on two levels for the customer. First, an increase in operations on their equipment which will decrease the life cycle of the device. Second, a repeated loss of power in which several aspects of their operations can be affected.

III. ATO TRY BACK WITH TIME DELAY

Modern ATO's with microprocessor-based relays can preset a time period for the voltage to return to normal to ensure normal conditions are not temporary. To coordinate with the recloser operation, the pre-set time must be greater than the time delay of the long operation. Electro-mechanical relays can be reviewed to verify that the return to normal conditions include time delay mechanisms, and that they can be set for long enough to account for the DA scheme. This method is the least expensive option that prevents excess operations and limits customer power loss, and it is also the most commonly used practice to coordinate customer ATOs and feeder reclosing schemes.

A. ATO WITH GENERATOR CONNECTION

When customers with critical load require additional contingency beyond what the dual source provides, many employ on-site generation. If the generator's

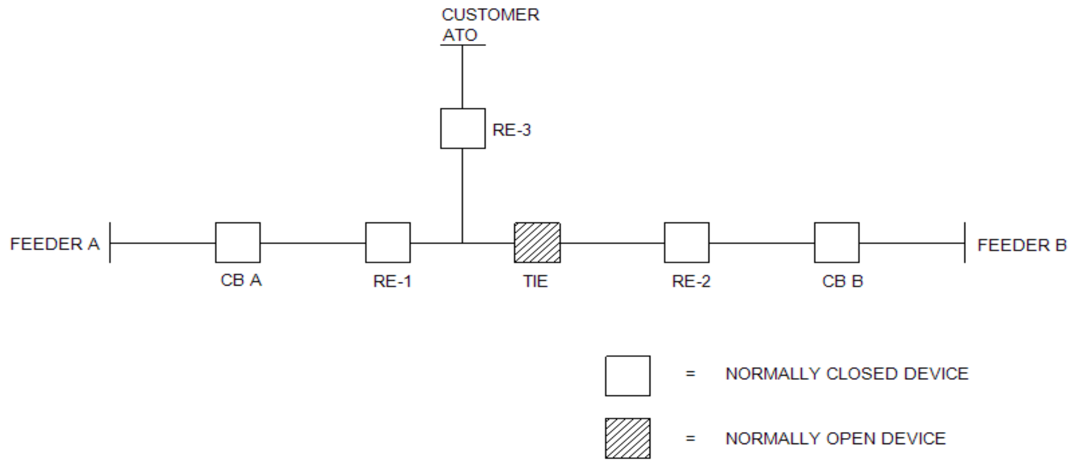

Figure 3. Stand Alone Recloser Configuration

start up sequences are initiated by the same parameters as the ATO, the shutdown sequence should be reviewed for when power is restored to prevent damage to the generator. Returning to power after a successful recloser scheme can cause the generator to start and stop in a relative short amount of time, reducing its life span. Adjusting the shutdown sequence to delay after return to power, such that the generator has enough time to cycle up and run before shutting down is necessary to prevent a reduced life span on the equipment.

IV. ATO RESTORE SET TO MANUAL

In scenarios with critical load customers that wish to control impact to operations and limit site power outages to just once until off hours, the try-back feature should be set to manual on the customer equipment.

In some extreme cases, where critical-load customers are returned to power via emergency tie, the customer will delay the return to normal. Instead, by utilizing the manual try-back feature, the return to normal can be scheduled and performed manually – after notification from the utility that all faults have been cleared and repaired - avoiding unscheduled, additional operations of the ATO occurring when the utility feed switches back from emergency to normal.

V. STANDALONE RECLOSER TO ISOLATE CUSTOMER

When adding a reclosing scheme to a system with an ATO where the above solutions are not viable, a standalone device can be set up to isolate the customer. This device can be programmed such that it acts as a remote switch. It will open when sensing a loss of voltage and must be told to close to restore power back to the customer. Space and system configuration constrain the ability to implement this device. It is only practical when the customer has a radial tap in which a device can be installed along the feeder, or directly at the customer site before the customer ATO. This prevents impact on other customers. Figure 3 illustrates how this device can be configured with a typical DA scheme.

This configuration requires an additional DA device capable of being programmed to open automatically at a loss of voltage. It also requires either a manual operation, or a remote signal to close back in. The operation sequence of configuration would work as follows:

Momentary Fault on Feeder A between RE-1 and Tie:

1. RE-1 begins its reclosing scheme
2. RE-3 would open and lock open
3. RE-1 clears the fault and returns to normal
4. RE-3 remains open until told to close

Non-momentary Fault on Feeder A between CB and RE-1:

1. CB begins its reclosing scheme
2. RE-1 Locks open after preset time
3. RE-3 locks open
4. Tie closes with initial overcurrent single lock out

With RE-3 set to only operate at a loss of voltage, any operations of the tie due to faults on Feeder B will not cause any disruption of service to the customer. This method can be applied to recloser schemes regardless of the DA scheme chosen and only relies on a recloser that can be set to operate when there is a loss of voltage and it remains open until manually reset.

VI. CONCLUSION

Most modern ATOs with microprocessor relays can prevent inadvertent switching operations by adjusting the timing of the return to normal. The specific adjustments required will depend on the reclosing scheme utilized and the capabilities of the ATO, but it can be handled on a case-by-case basis. Electro-mechanical ATOs can also be adjusted if the try-back has adequate time delay capabilities. Performing these adjustments should be the preferred method for integrating DA schemes as it requires no additional material.

When adjustments of the relay settings still cannot create the proper coordination between ATO and DA scheme, isolating the customer with a standalone device capable of locking open at a loss of voltage can avoid undue stress on customer equipment. This option would be the least cost effective as it requires an additional recloser in the field.

ABOUT THE AUTHOR

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Bryan Knowles is Primera's substation and distribution expert. His expertise is the result of over 10 years of experience in power distribution systems focusing on 4kV, 12kV and 34kV design for construction of overhead, underground and vault systems. His experience includes inspection, analysis and design of underground, vault and overhead electrical distribution facilities as well as preparing cost estimate evaluations, thermal analysis, grounding studies, fuse coordination and transformer sizing.

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