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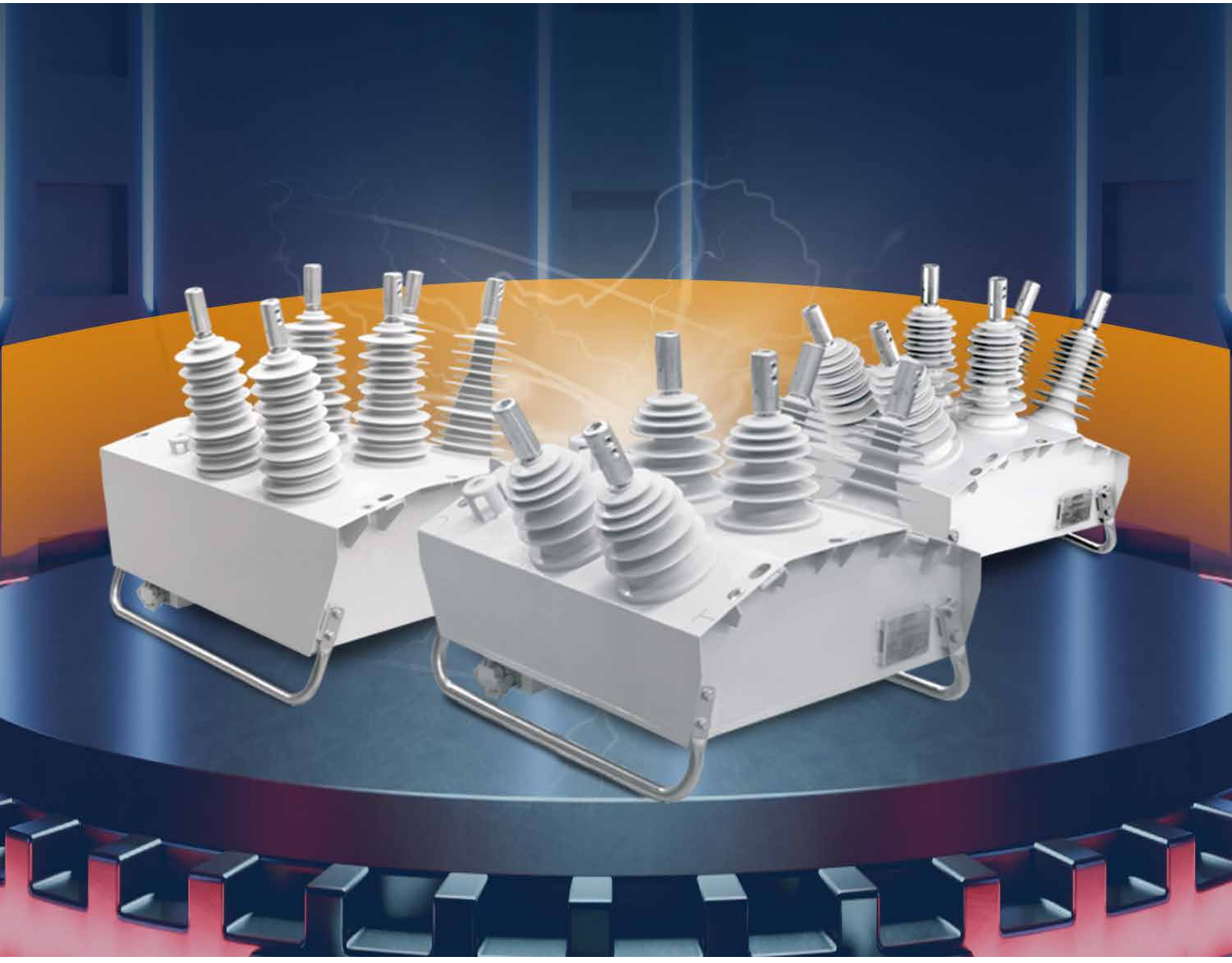

Different Medium Voltage

SWITCHING TECHNOLOGIES

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Content

1 INTRODUCTION

Interrupting equipment in modern distribution networks constitutes one of the most sensitive elements of the electricity supply chain. Designed for more demanding operations under severe conditions of electrical, mechanical, climatic, vandalic, and environmental requirements, including winds, dust storms, rain, hail, high-altitude locations with lower oxygen availability, among others; in this context, Reclosers are the best solution for most engineers operating and maintaining distribution networks. In recent years, the evolution of controllers has made even the most advanced relay somewhat nervous about competition regarding available functionalities and protections.

Recloser controllers are essentially industrial computers, which are a combination of the SCADA Remote Terminal Unit (RTU), driving control, and protection relays. They boast an increasingly extensive list of functionalities.

On the other hand, some developments have suggested that the Recloser can function as a Load Break Switch. This concept is theoretically possible in any Recloser controller, but it is confusing in terms of its practical application in networks (See Figure 1).

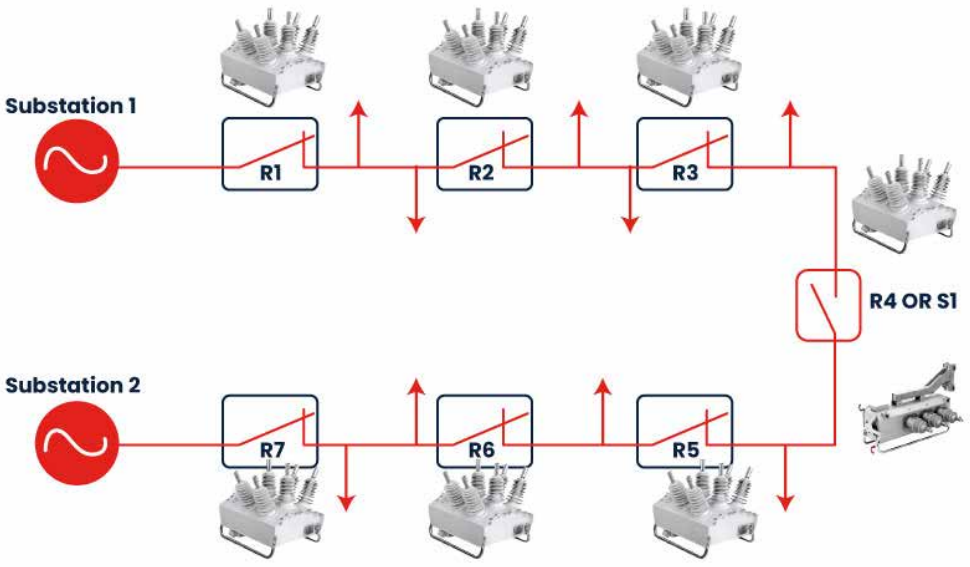

Figure 1: Diagram of a ring feeder with Reclosers.

2 OBJETIVE

The objective of this document is to analyze the advantages and disadvantages of operation to use a Recloser in the form of a Load Break Switch, considering quality, the incorporation of distributed generation, and/or safety.

3 RECLOSER

The Recloser is an automatic reclosing switch, preferably installed in radial distribution lines. It is a protective device capable of detecting an overcurrent, interrupting it, and automatically reconnecting to normalize the supply of electrical energy in the line (See Figure 2a).

4 LOAD BREAK SWITCH

A Load Break Switch (See Figure 2b) is an electro-mechanical switching device capable of establishing, supporting, and interrupting currents under normal circuit conditions, including specified overload conditions, as well as supporting abnormal currents (such as those from short circuits) for a specified period. This device can also be required to support (but not interrupt) short-circuit currents.

5 RECLOSER AS A LOAD BREAK SWITCH

Why would a Recloser, an equipment of significant economic value, be limited to acting as a Load Break Switch?

Figure 2a: Recloser

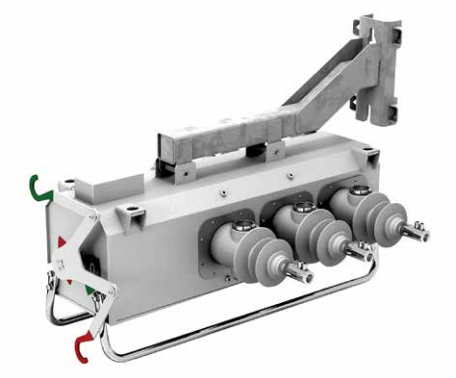

Figure 2b: Load Break Switch

In current trends in the world of modern electricity distribution, the application of using a Recloser as a Load Break Switch is gaining strength when exploring distribution lines, which is why a hybrid switch is the best solution.

A hybrid switch is a device that can act as a Recloser, Load Break Switch, and/or Power Switch.

Firstly, it is convenient to explore the classic role of the hierarchy of network equipment. At the lower end of the hierarchy, both in terms of cost and complexity, is the Load Break Switch; typically designed to interrupt supply under normal load conditions, being an economical solution for the recurring problem of disconnecting segments of a network. Over time, this technology has become more sophisticated with the addition of sensors and controllers.

With the incorporation of some current transformers (CTs) and controllers, Load Break Switches can alert network operators to the convenience of opening when high currents are flowing; but the most important aspect of these devices is their ability to share information with the control center through SCADA.

In the context of a smart grid, the generated information is of utmost importance for making informed decisions. The "smart" Load Break Switch, along with some CTs and elements with communication capabilities, can be implemented as a fault indicator; consequently, a device that normally does not have coordination requirements due to its lack of interruption protection capability can indicate a set of data to a central SCADA automation system to report that "a fault current has occurred"; with this information, operators can locate fault points and even reconfigure the network to isolate these points. A slightly smarter Load Break Switch could have economic justification for investment, considering the time and money saved by timely and lower-cost attention to potential interruptions.

At the next level of the hierarchy is the commonly known Sectionalizer. These distribution network elements essentially have fault indicators, as mentioned earlier, with the exception that now the switching operation is carried out automatically in the switch.

Instead of waiting for a remote command from SCADA operators, the Sectionalizer counts the operations of the Recloser upstream, as it monitors whether the power source is turned on or off again through the predetermined reclosing sequence. The Sectionalizer does not have the ability to break the fault current; however, it opens when the upstream equipment (Recloser) has broken the fault current. Programming a Sectionalizer only requires setting the number of trips that upstream equipment has to generate within a certain period of time before this equipment trips to isolate a line segment.

However, the advantages of using a sectionalizer are twofold: 1st, it does not represent a significant investment for electricity companies, and 2nd, it is immune to coordination requirements. The lack of fault current interruption of these devices limits their coordination capacity in more complex networks.

Traditionally, with a switch programmed in a Substation with a fault clearing time of 1 s and a margin of 250 ms between devices, up to a maximum of 4 Reclosers downstream of the substation could be coordinated. Many applications, especially at the outputs of larger feeders and main lines, could undoubtedly use more Reclosers than the suggested 4. While today's advanced Reclosers from some manufacturers, such as the OSM® series from NOJA Power, with an RC15 controller, could easily handle a 150 ms margin; if greater coordination times in protections are required, additional Sectionalizers can be incorporated.

In this way, by segmenting the lines, distribution companies have greater capacity to restore power and isolate faults more accurately. While this operation between Reclosers and Sectionalizers works well for radial lines, the challenge arises when distributed generation and alternative energy sources interact with line operation. Not all radial lines act as "radially" as before, because distributed generation and renewable energy sources can offer multiple fault flow paths.

This is compounded by coordination requirements on the ring feeders, as the loss of a supply path can cause multiple feeders to be tied together. When a large feeder with 4 Reclosers becomes a feeder with 8 Reclosers, coordination margins will be more demanding. This is

the competitive advantage for using such complex and highly available networks, the hybrid equipment.

When the current is flowing under conventional load conditions with an open connection point, coordination is not a problem. The challenge arises when a supply source is lost and the connection point is closed. This problem is related to meeting coordination requirements under a change in the direction of current flow. A modern Recloser, which can identify different current directions through the application of the torque angle sequence component, can selectively act as a Sectionalizer or Recloser depending on the network configuration automatically. For example, if Substation 1 is lost, Recloser R1 opens, but R2 will have trouble maintaining coordination in case of a downstream fault relative to the supply from Substation 2.

To address this challenge, R2 can be programmed to act as a Sectionalizer in this current flow path, to ensure coordination is met. During conventional and reverse operation (loss of Substation 2 and closed connection point), current flow occurs in the opposite direction and this equipment now becomes the second closest Recloser to the substation. In this operation, the switch should behave as a Recloser, as coordination is much less demanding at this point, and a second-line Recloser is expected to interrupt faults occurring downstream. With exceptional versatility, power distribution companies are now equipped with the ability to maintain coordination, even under difficult supply conditions. This level of performance ensures that the network remains coupled, regardless of configuration, performance improvement, and reliability.

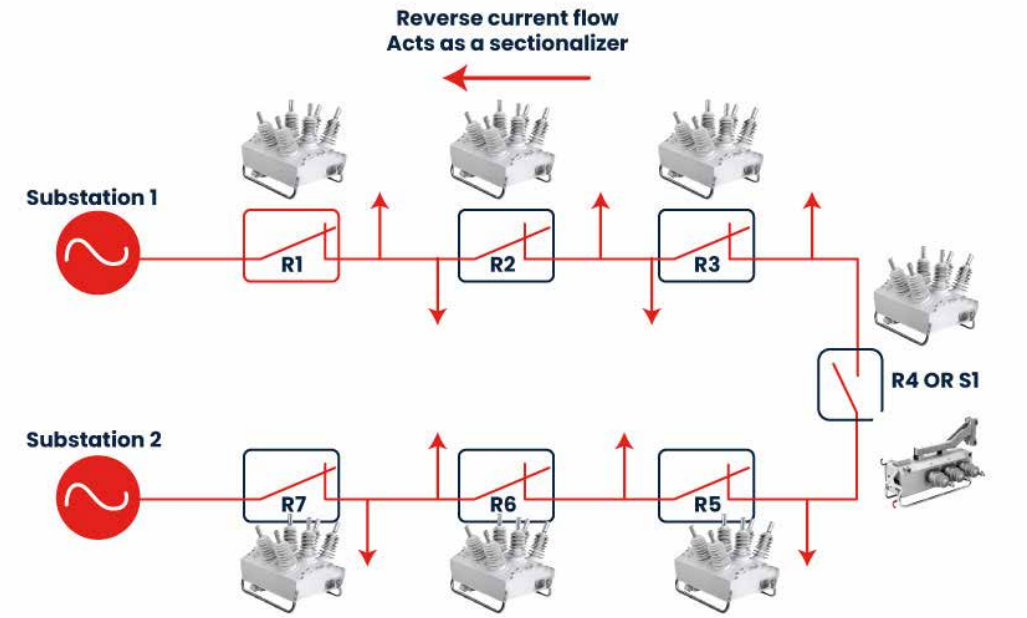

Figure 3a: Deployment of the hybrid equipment as a sectionalizer.

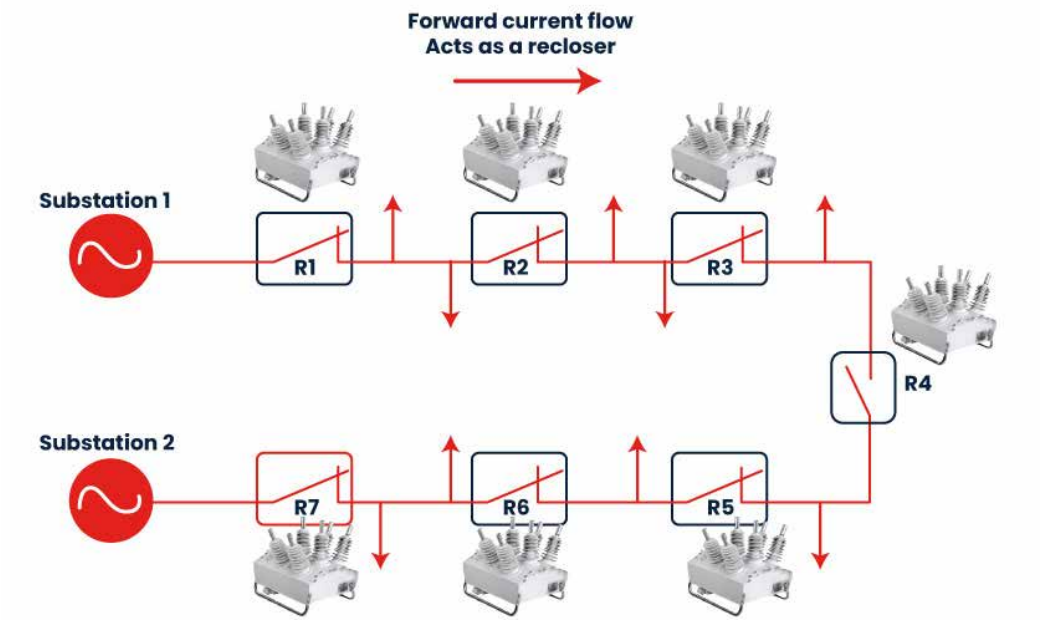

Figura 3b: Despliegue del equipo híbrido como Reconectador.

In practical terms, a Recloser could also fulfill the role of a fault indicator. Often, during network connection operations, distribution company operators deactivate the protection functions of Reclosers because intermittent variations could generate false trips and unnoticed supply interruptions. However, it would be wasteful to disable the protection function in these devices and essentially blind operators to the potential overloads that connection operations can cause. The solution implemented by some manufacturers, such as NOJA Power RC15, is known as "alarm mode", in which all protection functions are disabled and removed, but SCADA alarms continue to be triggered by overloads. This is a simple application to ensure that operators have the important information they need for their applications, but simultaneously allows them to continue working as they usually do, disabling the protection function when they are unsure about network response parameters.

6 SOLUTION FOR DISTRIBUTION COMPANIES

The hybrid operational capacity opens up a world of opportunities for distribution companies, as they can replace their traditional sectionalizers with modern Reclosers and update settings remotely, allowing them to use the equipment either as a sectionalizer or as a Recloser as required. Even better, this level of versatility has meant for some distribution companies that they only need Reclosers to meet all their range of distribution network connection requirements. This presents multiple advantages in cost savings, as it is a common piece of equipment that can satisfy all distribution network applications. Likewise, storage costs, required spare parts inventory, and training are minimal.

HIGH-QUALITY, HIGH-PERFORMANCE, AND SUPERIOR DURABILITY SOLUTIONS FOR THE MOST DEMANDING APPLICATIONS

7 CONCLUSION

Reclosers have undergone significant evolution, both from the perspective of cost reduction and the increase in functionalities, allowing them to function as an exclusive protection and control equipment in modern distribution networks, eliminating the need for sectionalizers and remote-controlled load break switches.

The cost of a Recloser is higher than that of a Sectionalizer; however, the benefits of the Recloser in achieving reliability and continuity of electricity supply are superior.

Using a Recloser as a sectionalizer represents significant savings for distribution companies in terms of work and time to restore power to their customers, additionally preparing them for the transition to smart grids.

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