INTEGRATED INSTALLATION OF A SWITCH WITH NO EXPOSED LIVE PARTS FOR MV OVERHEAD INSULATED NETWORKS

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ABSTRACT

This paper describes a SF6 load break switch specially designed for 20kV 630A overhead networks which are equipped with insulated cables.

INTRODUCTION

Parts of the Polish MV overhead network is made by insulated cables. Air break switches are used on them but they have several disadvantages compare to an SF6 load break switchgear. First, Air break switches have a low breaking capacity. Indeed, common 24 kV air break switches have low breaking capacity, around 50A to 200A for the strongest. While base SF6 switch can break currents around 400A to 630A. And as they are well protected in a tank, they are really more reliable. Furthermore, because or the long dielectric distance needed in the air, air break switches have a bigger size. More, the presence of several exposed live parts is risky for wildlife. Finally, they can hardly be upgraded with current and voltage sensors for smart grids.

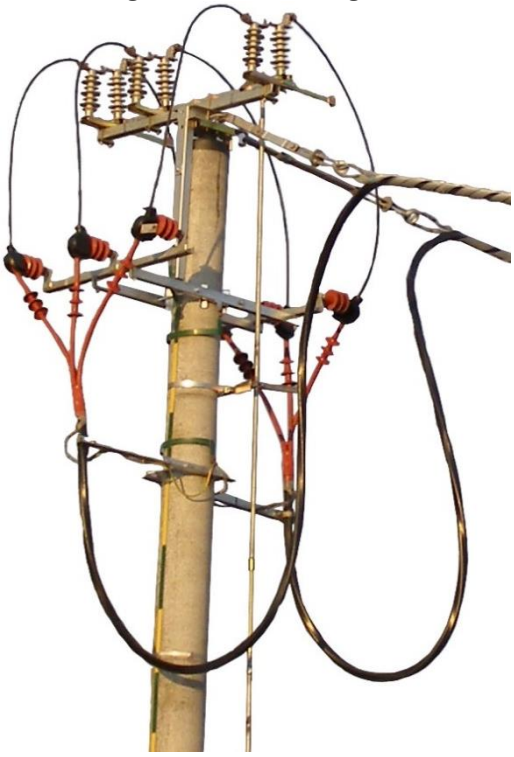

Figure 1: Example of an air break switch on MV overhead network equipped with insulated cables

In order to convince the Polish market to start using SF6 load break switch in those kinds of network, we must be able to propose a product which is easy to install and which has no exposed live part.

USUAL SOLUTION

Replacing an air break switch which is placed on their insulated overhead network by an SF6 switch may generate complicated installations and many live parts.

Several devices for the function

In a common installation of an overhead load break switch, besides the switch itself, there is many components which must be added and fixed on the pole.

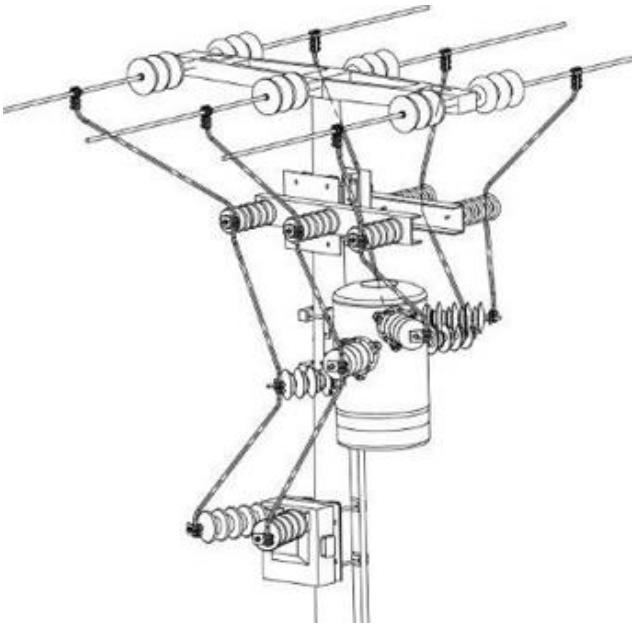

Figure 2: Example of a common installation of an overhead load break switch

Surge arresters and their brackets

It is not so usual that the same tender asks for switches and the surge arresters together. Most of the time, those markets are separate.

Almost all overhead switch installation, the surge arresters have their own mounting brackets. Typically, those surge arresters mounting brackets are not specially designed in order to be harmoniously connected to the

switch. Indeed, the geometric arrangement between the bushings of the switch and the surge arresters is not perfectly compliant and the connecting wires are long.

External voltage transformer
Except in the case of manual load break switches, a voltage transformer is needed in order to supply the auxiliaries of the switch, like its electric motor and its control cabinet. One more time, dedicated mounting brackets are usually needed for this MV/LV transformer as well as connecting wires.

All those components which must be installed on the pole make the mounting operation not so easy.

Many live lines

Common load break switches and voltage transformers are equipped with exposed terminals at the ends of their insulation bushings. Furthermore, the connecting brackets of classic surge arresters are not shaped to be insulated. In case of an overhead network made by insulated cables, it's a pity that this usual solution gives so many uninsulated connected points. That's why this is not seductive for the customer.

A way to facilitate the installation and to eliminate the exposed live part is to group those several organs in one.

NEW COMPACT INSTALLATION WITH NO EXPOSED LIVE PARTS

A very special SF6 load break switch is offered in order to replace this so large and unreliable air break switch.

Proved switchgear chosen for this issue

The base Ensto Novexia SF6 load break switch chosen for this issue is called Auguste. As it has been sold and installed on networks in fifty different countries for fifteen years, its reliability is proved. The Auguste is an overhead load break switch and a disconnector. Its rated voltage and current is 24kV to 36kV and 400A to 630A.
The Auguste is designed to maintain maximum network service if an element is assigned to an abnormal operation. They are installed downstream of the protections of substations or reclosers and allow: detecting a faulty section, isolating it and reconfiguring easily the network to keep the majority in service.

Remote and smart grid

Unlike an air break switch, an SF6 load break switch is dedicated to be controlled remotely. More, current and voltage sensors are usually integrated. In association with a control cabinet this integrated installation of an SF6 load break switch is able to be interfaced with a scada remote control system.

Internal Voltage transformer

The voltage transformer intended to supply the auxiliaries is embedded inside the enclosure of the switch. The act of integrate the voltage transformer inside the tank of the switch brings technical and economic advantages.

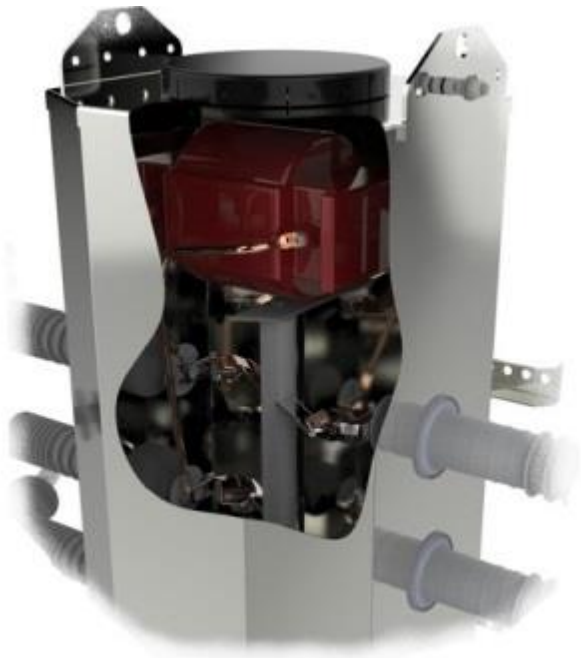

Figure 3: Voltage transformer embedded inside the tank

Effectively protected by a tank
The enclosure of the switchgear is made of 3 mm thickness stainless steel sheets. Its Protection index is IP68.
Because of the tank, the voltage transformer benefits of a high resistance to vandalism and to the most severe conditions of environmental stresses (saline humidity, wind, sand, ice, snow, high altitude, industrial pollution, area of high bird density, area of high population density ...).

Dielectric insulation given by the SF6 gas
The stainless steel tank is filled with SF6 gas at 0.3 bar. As the pressure is low, risks of leakage are diminished. A SF6 low pressure sensor is fixed on the lower part of the Auguste tank. In case the pressure decreases to 0.05 bar: A red fault LED is lit in the control box. The low pressure information is remotely transmitted to the scada.
This SF6 tank is sealed for life, no pressure verification nor gas filling is necessary during the whole product life of 30 years.
The internal voltage transformer benefits of the insulation given by the SF6 gas. It means that the distance between the phases doesn't need to be as big as in the air. In fact,

the size and the weight are reduced by half.

A secure and reliable solution

Many switchgear suppliers and some customers argue against this solution. We often heard that in case of a damage of the transformer, the switch will be destroyed too. The truth is that it's the same with a classic external transformer. External transformers are installed so close from the switch that they damage it in case of explosion. Indeed, big epoxy pieces are projected and strike the switch. In contrast, internal transformer solution has suffered the internal arcing test specified by IEC 62271-200. It guarantees the safety of the components around.
More, an outdoor transformer would need maintenance.
After all, this solution is acclaimed by customers who have tried it. Some of them use internal transformer for more than ten years and are very pleased of its reliability. Indeed, switches damaged due to the transformer have been very rare.

A pole mounted installation simplified

Of course, to have a transformer embedded inside the tank of the switch makes the installation really easy and shorter.
The switch must be installed on the good side of the pole in order to be oriented in direction of the source side. By this way, the phases of the switch connected to the transformer are supplied all the time. A transformer symbol is engraved on the feeder side of the tank in order to identify it easily.

A cost effective solution

All those points described hereafter make the internal voltage transformer solution cost effective. Because of its smaller size, the price is reduced by half. The labor price of installation has to be subtracted. The good reliability of the solution makes it a long-term investment.

Testing

The switch has to withstand the dielectric tests specified by the IEC 62271-103, even if the primary phases of the voltage transformer are connected to its bushings. The rated lightning impulse withstand voltage for a 24 kV switch is 125 kV and the rated power-frequency voltage is 50 kV. Furthermore, those internal voltage transformers have passed the type and routine tests specified by the IEC 60044-2 standard: temperature-rise test, short-circuit withstand capability test, impulse test on primary winding, power-frequency withstand tests and partial discharge measurement.

Connection to the line with no live parts

In addition of the internal transformer, this SF6 load break switch offers another innovation: a completely insulated connecting system equipped with integrated surge arresters.

Bushings and connectors

The switch is equipped with outdoor-immersed bushing interface C type in order to plug separable connectors.

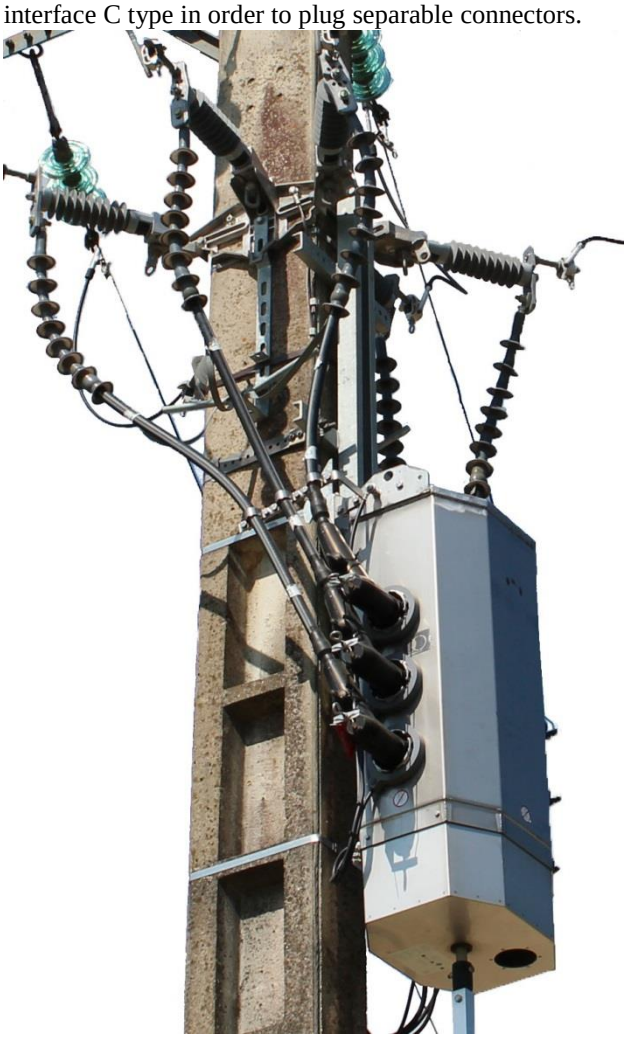

Figure 4: Auguste SF6 load break switch equipped with separable connectors on the French network

Using separable connectors is not common on an overhead SF6 load break switch but it is used on the French 20kV network since 2000.

Surge arresters linked to the connectors

The surge arrestors are plugged on the top of T separable connectors. As well, this kind of technical solution is not used so far on overhead networks but their technical characteristics are perfectly indicated in this application.

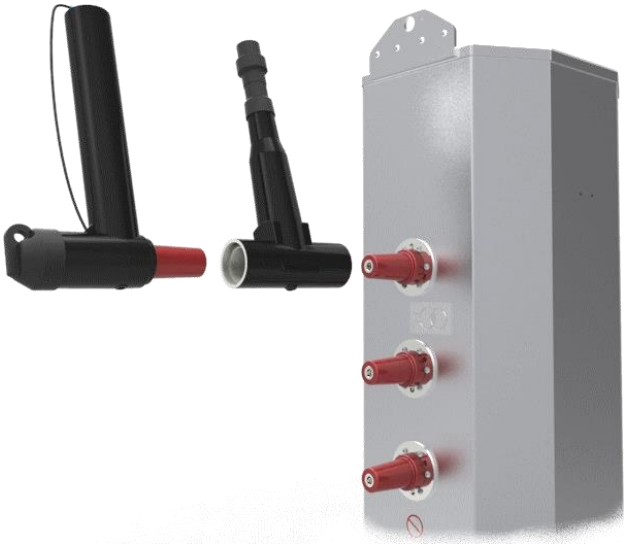

Figure 5: Surge arresters and T separable connectors

On this issue, we have used 24kV surge arresters and separable connectors from Euromold.
In order to withstand the weight of the connectors and of the plugged surge arresters, and to prevent any SF6 leakage, the mechanical link between the tank and the male connectors have had to be upgraded.

This compact connect solution ensures that no live parts will remain. Furthermore, it makes sure that the connection operation is quite simple and fast.

SEDUCTIVE POLE MOUNTED INSTALLATION

Due to the addition of those two previous technologies: an internal transformer and the connecting solution, installations are greatly simplified and compact. Only one component is installed on the pole.

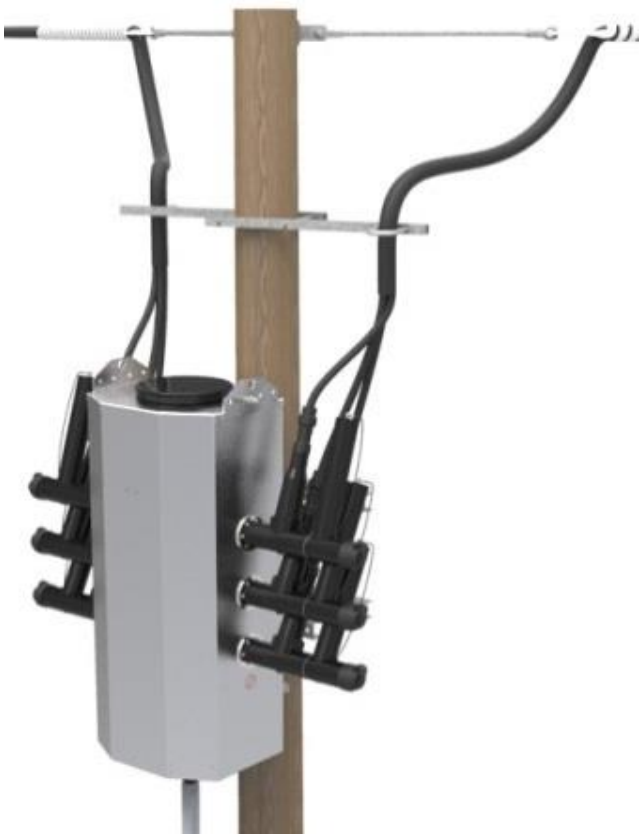

Figure 6: Addition of an internal transformer and the connecting solution

The equipment is well protected against overvoltage due to the closeness of the surge arresters. And there are no more exposed live parts.

CONCLUSION

As the Polish specification was to replace very easily an air break switch by an SF6 load break switch with no live part, an August switch equipped with an internal voltage transformer and separable connectors with surge arrestors plugged into gives satisfaction. Beyond the several advantages given by a load break switch, like the rated breaking current level or the safety operating method, the overhead network may benefit of the remote control possibility or the sensors integration for smart grids. And all those advantages are given by a very simple and compact integrated pole mounted installation.