

## MEASURES FOR SUPRESION APERIODIC CURRENT COMPONENT AT SWITCHING EXTRA-HIGH VOLTAGE LINES 750 kV BY SF<sub>6</sub> BREAKERS

**General characteristics of the problem.** In main power electrical networks of Ukraine, the replacement air circuit breakers on sulfur hexafluoride (SF<sub>6</sub>) circuit breakers were implemented. This modernization is due to the fact that the modern electrotechnical industry does not manufacture air switches and, in case of accident, repairs these breakers and renews electrical supply will be impossible. In comparison with air circuit breaker, the SF<sub>6</sub> has certain advantages, the main ones being the speed and high switching power, as well as the possibility of installing an additional control switching device and pre-insertion resistors. The switching point of an SF<sub>6</sub> circuit breaker is a probabilistic parameter and it is impossible to perform switches at the required moment without the use of controlled switching. Such a disadvantage during the operation led to emergency situations, including the appearance of aperiodic (AP) current component at electromagnetic transients [1-3]

**The aim of article** is to study the conditions for the appearance of unacceptable values and the duration of the AP current component of the transition process to avoid damage of the poles SF<sub>6</sub> circuit breakers. This goal implies developing measures to prevent possible emergency situations in extra-high voltage lines 750 kV.

**Proposed approach to problem solving.** In this work, the modes of operation of switch are considered in the fast "on/off" cycle of the pause a three phase automatic reclose of extra high voltage line 750 kV, when at the moment of connection in the current of the switch there is mainly AP component whose value is not more than several hundred amperes. The presence of a significant AP causes long burning of the arc on the contacts and, as a result, a significant increase in the temperature of the gas and the growing of pressure inside the arc camera. The contacts of the switch during long burning of the arc can boil with each other. So, the initial value of the AP current component, for example in phase A (Fig.1), depends on the moment of closing the contacts of the switch. The permissible value of AP component for SF<sub>6</sub> circuit breakers 750 kV is 58% of total current at the transition process.

One of the solutions to mitigate the risk related to the magnitude and duration of AP component is pre-insertion resistors (PIR). There are basically two different PIR configurations: parallel and series. In parallel PIR configuration, the resistor switch is in series with the resistor bank, and both are in parallel with the circuit breaker interrupter, where the interrupter operation follows the PIR switch operation. In a series PIR configuration, the resistor switch is in series with the circuit breaker interrupter but in parallel with an overhead line. The second traditional measure to reduce the magnitude and duration of AP component is energizing overhead line by controlling the closing moments of the circuit breaker poles [3]. The purpose of this device is to close and/or unlock the terminals of the switch at the required point of the sinewave of the current or voltage. It should be noted that ABB (Asea Brown Boveri Ltd.) has developed switching device SwitchSync F236 [3], which is intended for SF<sub>6</sub> switches with polar control.

It should be noted that nowadays don't exist studies in which compare the effectiveness of the PIR using of different designs in combination with a controlled switching device for suppressing the AP current component. The (Fig.2) shows the results of comparing the efficiency of the application of two designs of PIR in combination with a control switching device. As can be seen from (Fig. 2), when using a PIR connected in series to the circuit breaker, it will be possible to suppress the AP component and, consequently, such a measure can be recommended for installation on extra-high voltage lines.

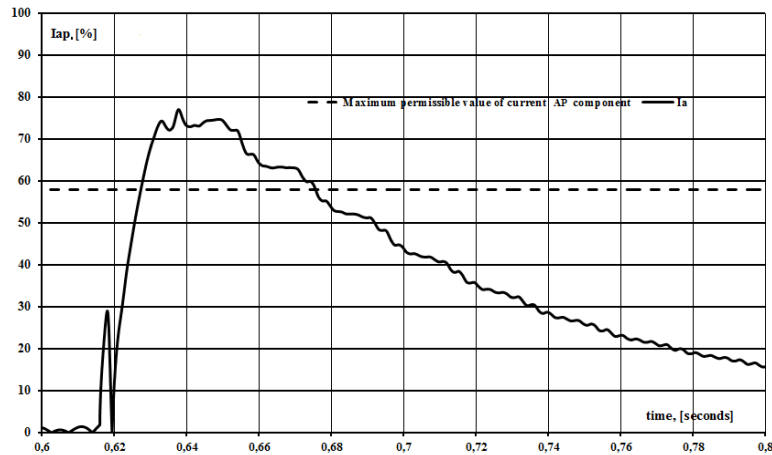


Figure 1 – Excess the current AP component the maximum permissible value

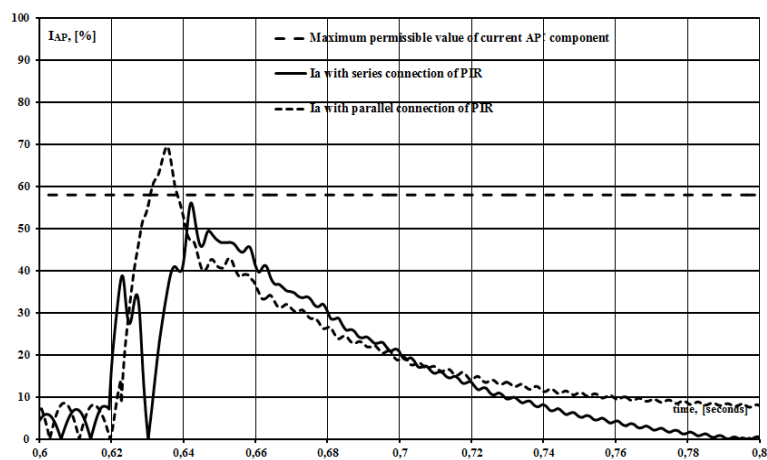


Figure 2 – Comparison the effectiveness of the PIR using of different designs in combination with a controlled switching device

### Conclusions.

Thus, although the replacement of the traditional air circuit breakers on SF<sub>6</sub> as rule, leads to an increase reliability of electrical supply, nevertheless, it can be concluded that it is necessary to perform before the modernization the preliminary analysis of transient processes arising from switching, in particular the value of the current aperiodic component. The measure for preventing failures caused by the inability of the SF<sub>6</sub> circuit breaker poles to interrupt current that does not cross zero for a long period of time due to the presence of large aperiodic component is suggested.

### References

1. Tugay Y.I., Mel'nychuk V.A. Transients in power distribution devices with SF<sub>6</sub> breakers // Pratsi Instytutu elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy – 2014. – №39. – P. 5–9.
2. Beanland M, Thomas S., Rostron P. Pre-insertion resistors in high voltage capacitor bank switching // Proceedings of international conference on western protective relay– 2004. – P. 1–12.
3. Controlled Switching // Buyers & Application Guide, Edition 3.1. ABB. – 2010. – P. 54.

### Список використаної літератури

1. Тугай Ю.І., Мельничук В.А. Перехідні процеси в розподільчих пристроях електростанцій з елегазовими вимикачами // Праці Інституту електродинаміки Національної академії наук України – 2014. – № 39. – С. 5–9.
2. Beanland M, Thomas S., Rostron P. Pre-insertion resistors in high voltage capacitor bank switching // Proceedings of international conference on western protective relay– 2004. – P. 1–12.
3. Controlled Switching // Buyers & Application Guide, Edition 3.1. ABB. – 2010. – P. 54.