Internal services simulation control in 220/110kV power transformer station Mintia

D Ciulica and R Rob

Politehnica University of Timisoara, Department of Electrical Engineering and Industrial Informatics, 5 Revolution Street, Hunedoara, 331128, Romania

E-mail: raluca.rob@fih.upt.ro

Abstract. The main objectives in developing the electric transport and distribution networks infrastructure are satisfying the electric energy demand, ensuring the continuity of supply to customers, minimizing electricity losses in the transmission and distribution networks of public interest. This paper presents simulations in functioning of the internal services system 400/230 V ac in the 220/110 kV power transformer station Mintia. Using simulations in Visual Basic, the following premises are taken into consideration. All the ac consumers of the 220/110 kV power transformer station Mintia will be supplied by three 400/230 V transformers for internal services which can mutual reserve. In case of damaging at one transformer, the others are able to assume the entire consumption using automatic release of reserves. The simulation program studies three variants in which the continuity of supply to customers are ensured. As well, by simulations, all the functioning situations are analyzed in detail.

1. Introduction

In order to ensure the continuity in customer supplying, reserve circuits and power suppliers are assumed. For the investment reduction, whenever is possible, the reserve circuits are used to provide power to direct circuits, taking into consideration of a reduced probability for two failures coincidence. The purpose for using the automatic release of reserves (ARR) is to serve for supplying the customers when the direct circuits suffered a fault. The measuring device detects the voltage absence on the collecting bars and transmits the command for switch releasing which ensures the customer supplying by reserve circuits.

During the functioning of an electro-energetic installation, two different situations may occur and they can be determined by the fault location:
- situation when ARR intervention is necessary;
- situation when ARR intervention is not useful.

The ARR device scheme is presented in Figure 1. The block scheme contains [1]:
- starting element which actions when the voltage is falling lower then 0.7·Un;
- control element which conditions the functioning by the presence of the supplying voltage on the I2 switch.
- temporization element which may deprive.
- blocking element to repeating actions.

In order the ARR installation to make difference between the situations described in this section, it has to accomplish the following conditions [2], [3]:
- ARR releasing when the voltage on the consumer bars falls below a specified value.
- ARR releasing must be accomplished only after the specified time $t_{ARR}$;
- the reserve circuits must be released only after the direct circuit is disconnected;
- ARR must work only once, if the relay protection commands a new releasing, ARR must not respond.

![Figure 1. AAR device block scheme](image)

2. **Supplying general scheme**

Power transformer station Mintia (220/110 kV) serves for transporting the electric energy to consumers which are supplied to 110kV (local power transformer stations of 110/20kV or 110/6kV). The single line scheme of the power transformer station Mintia is presented in Figure 2.

In order to supply the station internal services, three transformers are used and they can mutual reserve. So, in case of one’s failure, the other two are able to assume the entire consumers using an ARR installation [4]. The supplying scheme contains simple longitudinal sectioned bar using a switch coupling. Each section has a subsection for vital consumers and one for non-vital consumers.

The scheme presented in Figure 2 is realized in Visual Basic and it permits to the user to choose the appropriate supplying way when a fault occurs. In many situation simulation is very useful to study the functioning of some electrical circuits [5-9]. In the actual situation the monitoring and control is based on SCADA, a control system architecture that uses computers, data communications and graphical user interfaces for process supervisory management [10].

In the followings, the power transformers T11 (10/0.4 kV, 800 kVA), T21 (10/0.4 kV, 800 kVA) and T31 (6/0.4kV, 600 kVA) are the supplying sources. If from various reasons, none of these sources becomes unavailable, a Diesel generator with the apparent power of 500 kVA must assume the entire consumers for up to 12 hours [10].

3. **Functioning of the ARR in the internal services of power station Mintia**

The 0.4 kV power station is composed by two bar sections, connected by a longitudinal couple (Q104). Section 1 is supplied by T11 transformer using Q101 switch, or by T31 transformer using Q103 switch, or by Diesel generator using Q200 switch. Section 2 is supplied by T21 transformer using Q201 switch, or by T31 transformer using Q203 switch, or by Diesel generator using Q200 switch.

In the followings, three methods for supplying consumers will be presented when fault occurs on the direct circuits.
3.1. **Consumers are connected on Section 1 and Section 2 and supplied by PT1 (T11)**
This is the first method for connecting the customers when the fault occurs. From Figure 3 it can be seen that in variant 1 the Q104 and Q101 switches are connected and Q103, Q203, Q 201, Q102, and Q202 are disconnected. Elements as Diesel generator, Q200, Q105, and Q205 switches are on the ‘don’t care’ level.

3.2. **Consumers are connected on Section 1 and Section 2 and supplied by PT3 (T31)**
From Figure 4 it can be seen that in variant 1A the Q104 and Q103 switches are connected and Q101, Q203, Q 201, Q102 and Q202 are disconnected. Elements as Diesel generator, Q200, Q105 and Q205 switches are on the ‘don’t care’ level.

3.3. **Consumers are connected on Section 1 and Section 2 and supplied by PT2 (T21)**
From Figure 5 it can be seen that in variant 2 the Q104 and Q201 switches are connected and Q103, Q203, Q 101, Q102 and Q202 are disconnected. Elements as Diesel generator, Q200, Q105 and Q205 switches are on the ‘don’t care’ level.

3.4. **Consumers are connected on Section 1 from PT1 (T11) and Section 2 from PT2 (T21)**
From Figure 6 it can be seen that in variant 3 the Q101 and Q201 switches are connected and Q103, Q104, Q203, Q102 and Q202 are disconnected. Elements as Diesel generator, Q200, Q105 and Q205 switches are on the ‘don’t care’ level.
3.5. Consumers are connected on Section 1 from PT3 (T31) and Section 2 from PT2 (T21)

From Figure 7 it can be seen that in variant 3A the Q103 and Q201 switches are connected and Q104, Q101, Q203, Q102 and Q202 are disconnected. Elements as Diesel generator, Q200, Q105 and Q205 switches are on the ‘don’t care’ level.

Figure 8 presents the signalling panel with the protection system state for the 400 kV cell afferent to 400/220kV autotransformer AT4.
*Figure 5.* Scheme for Variant 2

*Figure 6.* Scheme for Variant 3
Figure 7. Scheme for Variant 3A

Figure 8. Signalling panel with the protection system
4. Conclusions
The states in which the installation is able to be are the followings:
1. The normal state where three situations can be distinguished:
   - all the three base sources are available (T11, T21, T31). These situations were described in present paper as variants 1, 2 and 3 using ARR system;
   - all the three base sources are available, but Section 2 is retired from service;
   - all the three base sources are available, but Section 1 is retired from service.
2. If one of base sources in function presents abnormal parameters and one of the other sources works normally, the ARR installation will assume the entire energy consumption.

References
[1] Deshpande M V 2009 Elements of electrical power station design, PHI Learning publisher.
[2] Iagar A, Popa G N, Dinis C M and Moraru G 2009 Study about Numerical Relay SEL-387 for Overcurrent and Differential Protections of 110/20 kV Transformers, 13th WSEAS International Conference on Systems held at the 13th WSEAS CSCC Multiconference, Rhodes Isl., Greece, July 22-24, pp 265 – 270
[3] Popa G N, Deaconu S, Dinis C M and Iagar A 2009 Implementation of a Numerical Distance Relay for the 110kV Electric Lines, 13th WSEAS International Conference on SYSTEMS held at the 13th WSEAS CSCC Multiconference, Rhodes Isl., Greece, July 22-24, pp 271 – 276
[4] Milligan M, Donohoo P and Lew D 2010 Operating reserves and wind power integration, 9th Annual International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants Conference Québec, Canada, pp 1 – 19
[5] Panoiu C, Panoiu M, Muscalagiu I and Iordan A 2010 Visual Interactive Environment for Study the Power Electronics Using PSCAD-EMTDC Simulation Program, Computer Applications in Engineering Education 18 (3) 469-475
[6] Panoiu M, Panoiu C, Sora I and Osaci M 2007 About the possibility of power controlling in the three-phase electric arc furnaces using PSCAD EMTDC simulation program, Advances in Electrical and Computer Engineering 7(1) 38-43
[7] Baciu I and Cuntan C D 2012 Operation Analysis of a Frequency Converter with Control Realized in Labview, IEEE International Conference On Industrial Technology (ICIT), 19 – 21 March, Athens Greece, pp 432 – 437
[8] Baciu I, Cuntan C D and Gabor B 2014 The study of the electric parameters of an autonomous supply system with photovoltaic panel, International Conference and Exposition on Electrical and Power Engineering (EPE), Iasi, Romania, October 16-18, pp 1138 – 1143
[9] Dinis C M and Popa G N 2014 Measurements in Scada System used at a Wastewater Treatment Plant, Annals of Faculty Engineering Hunedoara XII(4) 207-215
[10] Chen K, Parmee I C and Gane C R 1997 Dual mutation strategies for mixed-integer optimisation in power station design, IEEE International Conference on Evolutionary Computation, 13-16 April, Indianapolis, USA, pp 385 – 390