DOI: 10.20396/revpibic2720192704

STUDY OF THE METHODOLOGIES AND PRACTICES EMPLOYED IN SIMULATIONS AND TESTING OF PROTECTION SYSTEMS

Wellter Mompean Sozin*, Maria Cristina Tavares, Ozenir Farah da Rocha Dias.

Abstract
Electrical power systems are indispensable and their global socioeconomic importance is indisputable, so it is necessary that their protection systems work precisely as desired. In order to guarantee this accuracy, it is possible to perform tests on these devices, and the methodologies for this are basically two: open-loop simulation and closed-loop simulation. Therefore, this work presents data that support the need to perform these tests and a comparative of their methodologies for a real electrical system using RTDS and ATP.

Key words:
ATP, Protection Systems Testing, RTDS.

Introduction

In order to have high continuity supply rate, electric power systems must be operated in a safe manner while maintaining the equipment life. The protection systems, composed of micro controlled relays, IEDs (Intelligent Electronic Devices) are designed to perform this task.
In faults situations, the IEDs must promptly detect the disturbance and send a trip signal to the circuit-breakers to isolate the smallest compromised portion of the electrical system[1]. This behavior is defined by the reliability, selectivity and speed of the IEDs, which in turn depend on their quality and setup designed by the protection engineers.
Basically, there are two methodologies that allow an IEDs test[2], the open-loop simulation, in which the IEDs are submitted to the analog signals that represent the fault cases, and the closed-loop simulation, in which the dynamics of fault cases are inputted to the relays that interact with a simulated power system.

Results and Discussion

The report prepared by Brazilian Energy Agency (ANEEL) compiles the forced disconnection of Interconnected Brazilian System (SIN). In its 2017 Edition 1096 occurrences in the transmission system (29.1% of total disconnections in the period from July 1, 2015 to June 30, 2016)[3] are summarized.
A survey was performed among these 1096 occurrences, and it was verified that 34 (3%) are related to protection systems, and their causes are presented in Image 1.

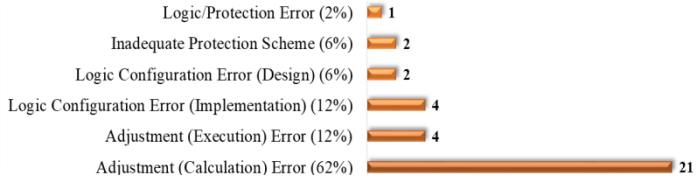

Image 1. Classification of causes of forced disconnections related to protection systems.

Thus, it is noted that occurrences related to protection systems are due in large part to protection adjustment errors. However, these errors can be easily detected and corrected when protection relays are tested before they are installed in the field.
In order to analyze the simulation and test methodologies, a case study of transformer differential of TR1 transformer (function 87T) in a real electric system shown in Image 2 was carried out.

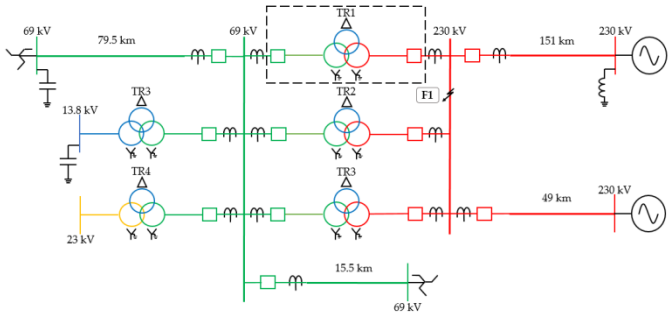

Image 2. Actual electrical system under test.

The open-loop simulation was performed using the ATP software together with test box and the closed-loop simulation was implemented through the RTDS and amplifiers. In both cases, tests were performed with the same adjustment of SEL-787 relay for this situation.

Conclusions

This work enabled the collection of data that show the importance of performing protection pre-field tests, allowing to avoid possible situations that compromise the quality of electricity transmission service performance. Electrical companies suffer severe penalties when the electrical system is unavailable due to PVI fees (Variable Portion due to Unavailability).
Moreover, the analysis of the elementary methodologies to carry out these tests allowed a better discrimination of the advantages and disadvantages inherent in each test type. Based on that, it is possible to have a more appropriate choice of either open-loop or closed-loop test for each specific situation.

Acknowledgement

I thank all those who cooperated for the development of this project, citing here the members of LTRANSP for the transmitted knowledge and FAPESP (2018/06740-0; 2017/20010-1) for the support.

---

[1] Kindermann, G. *Proteção de Sistemas Elétricos de Potência: Volume 1*. 3ª ed. Florianópolis, **2012**.
[2] Cardoso, P. E. P. *Avaliação do Impacto em Comissionamento e Testes de Funcionamento numa Subestação com Protocolo CEI 61850*. FEUP, **2013**.
[3] ANEEL. *Relatório de Análise de Desligamentos Forçados do Sistema de Transmissão – Edição 2017*. **2017**.