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Impact of Instrument Transformer Secondary Connections on Performance of Protection System: Experiences from Indian POWERGRID

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Abstract : Protective relays are commonly connected to the secondary windings of instrument transformers, i.e., current transformers (CTs) and/or capacitive voltage transformers (CVTs). The purpose of CT and CVT is to provide galvanic isolation from high voltages and reduce primary currents and voltages to a nominal quantity recognized by the protective relays. Selecting the correct instrument transformers for an application is imperative: failing to do so may compromise the relay's performance, as the output of the instrument transformer may no longer be an accurately scaled representation of the primary quantity. Having an accurately rated instrument transformer is of no use if these devices are not properly connected. The performance of the protective relay is reliant on its programmed settings and on the current and voltage inputs from the instrument transformers secondary. This paper will help in understanding the fundamental concepts of the connections of Instrument Transformers to the protection relays and the effect of incorrect connection on the performance of protective relays. Multiple case studies of protection system mal-operations due to incorrect connections of instrument transformers will be discussed in detail in this paper. Apart from the connection issue of instrument transformers to protective relays, this paper will also discuss the effect of multiple earthing of CTs and CVTs secondary on the performance of the protection system. Case studies presented in this paper will help the readers to analyse the problem through real-world challenges in complex power system networks. This paper will also help the protection engineer in better analysis of disturbance records. CT and CVT connection errors can lead to undesired operations of protection systems. However, many of these operations can be avoided by adhering to industry standards and implementing tried-and-true field testing and commissioning practices. Understanding the effect of missing neutral of CVT, multiple earthing of CVT secondary, and multiple grounding of CT star points on the performance of the protection system through real-world case studies will help the protection engineer in better commissioning the protection system and maintenance of the protection system.

Keywords : bus reactor, current transformer, capacitive voltage transformer, distance protection, differential protection, directional earth fault, disturbance report, instrument transformer, ICT, REF protection, shunt reactor, voltage selection relay, VT fuse failure
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