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Tap Changer Condition Assessment Using Dynamic Resistance Measurement

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Abstract

The DVtest method (Dynamic Resistance Measurement - DRM) is an off-line, non-destructive testing method based on a dc current being injected through a winding and a tap changer as it moves through all of its positions. The test current is recorded with high resolution. Also, an on-load tap changer (OLTC) motor current can be recorded simultaneously with the test current. A high sampling rate is very important due to fast transition processes (transition time of a resistor OLTC type is approximately 50 ms). The DRM method has been proven as a very effective method in the early detection of possible faults on on-load tap-changers (OLTCs). This test may be used to detect problems such as slow transition time, open circuits, problems with contacts, transition resistors, mechanism, motor control, and much more. This paper provides the description of the DVtest method for OLTC analysis. In addition, a few interesting cases about detected tap changer defects and diagnostic analysis are presented, as well.

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Keywords: Tap changer, DRM, Transformer, OLTC, Transformer maintenace, OLTC failures

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1. Introduction

The international statistical failure data analysis has been presented for a sample of 47000 transformer-years [1]. This analysis shows the tap changer failures represent more than 40% of all failures on power transformers. As outlined in the WECC meeting presentation [2], one in 20 tap changer failures lead to a transformer main tank failure. Major advantages of the DVtest method are the fast measurement procedure and reliable test results. The condition assessment of the OLTC transition contacts can be performed without opening transformer tank. The measurement is performed very quickly without a need to discharge energy accumulated in the transformer and then to recharge the test current when taps are changed. There is no a perfect test, and having more than one in the "tool box" is preferable when making a decision to take a transformer out of service for repair. The DRM graph pinpoints an exact location of defects indicated by a high level of gasses, or the Bucholtz operation causing tripping the transformer out of service. This approach saves time and money. The DVtest graph irregularities can indicate the OLTC problems such as contacts, mechanism, energy accumulator, and motor problems. All of them being dynamic problems, they are not visible with winding resistance tests.

Results from the current signatures are examined and compared against previous tests, similar units, or other phase test results. The analysis of DRM graph shape and its characteristic parts gives useful information about tap changer condition. There are different variations of OLTC models in the field. The reliable, trustworthy OLTC analysis requires understanding principles of regulation and OLTC operation. Each type of a tap changer belongs to a group of units operating in the similar manner. As a new method, the test has been used in the past 15 years by utilities in Europe and over the last 5 years it has been accepted in the USA as applied to the reactor tap changers. The new three phase method allows performing all three phases DRM simultaneously, and verifying synchronization of YN connected multiple OLTCs in a transformer. This method, recording the test current - is the only one applicable to both resistor and reactor tap changer type. In addition, the tap changers incorporating a series transformer can be verified as well.

2. DVtest method

DVtest provides certain information about an OLTC condition without the OLTC removal from the main tank, which is an expensive and time consuming job. The measurement is performed very quickly without a need to discharge the transformer and then to recharge it again for all tap changes. A DC current is injected through a winding and the OLTC as it moves through all of its positions. A DC current is recorded with a high sampling rate. A high sampling rate is very important due to fast transition processes (transition time of a resistor OLTC type is approximately 50 ms). The minimum 10 kHz sampling rate (0.1 ms) is required for a quality OLTC analysis. When switching from one position to the next, the resistors are incorporated in the circuit to minimize arcing and to lower the circulating current during the short period when the portion of the winding between the taps is shorted. The current graph during the transition (between two tap positions) provides diagnostic information of the tap changer performance. Speed, transition time, ripple, and other important features may provide indication into possible defects of the tap changer. See the Figure 1.