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1 X 1000 Kva Transformator Measurement Analysis Using Vector Group Dyn-11 and Off Load Tap Changer

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ABSTRACT

The problem of this research is to generate electrical energy in the power plant which is located far from the load center, so it requires a transmission line in order to be distributed to the public. The purpose of this research is to find out the ratio on the primary (20,000Volt) and secondary (400Volt) power transformers using off load tap changer, then observe, operate, and analyze the comparison of calculation results with the Transformer Turn Ratio (TTR) tool. The proposed method is an analysis of the condition of the transformer in a state of extinguishing to find out the condition of the transformer's entangler. The comparison results that have been done can be known at a voltage of 40VAC, obtained the results of testing the TTR measuring instrument when it exceeds the tolerance limit of 0.5% then the measurement results on one of the coils undergo a change in ratio. Suggestions that transformers are routinely checked, because if ignored potentially unbalance voltage on one of the coils and it will result in loss of voltage.

Keywords: *Transformer, Vector Group, Load Tap Changer*

1. INTRODUCTION

Public life and electrical energy are two things that cannot be separated in this modern era [1]. The availability of adequate electricity is a prerequisite for improving people's welfare through the industrial sector [2], the development sector [3], and the economic sector [4] which must be accompanied by an electric power system with a high level of quality and reliability. The electric power system consists of a generating system, a transmission system, and a distribution system [5]. The location of the power plant which is not always close to the load center means that electricity must be channeled through transmission and distribution lines in order to reach consumers. One part that cannot be separated from the distribution transmission line is the substation. The substation is a collection of extra-high voltage electrical equipment that has an important role in transforming electrical power as well as a control center to coordinate between the generating system and the distribution system [6].

A transformer is an electrical device that can change the level of an AC voltage to another level. The purpose of changing these levels includes reducing the voltage or increasing the voltage. This transformer or transformer works based on the principle of electromagnetic induction and can only work on alternating current (AC) [7]. Transformers (transformers) play a very important role in the distribution of electricity. The transformer raises the electricity from the PLN power plant to hundreds of kilo volts for distribution, and then the other transformers reduce the voltage required by every household and office, which generally uses 220Volt AC voltage. is the most important asset in the electricity transmission and distribution system. Apart from routine correct maintenance, testing is also very necessary to detect any disturbances or damage to the transformer. So doing various types of measurements that describe the actual condition of the equipment being measured is one way to prevent damage to the transformer. The transformer tests are carried out according to SPLN'50-1982 [8] by going through three kinds of tests, as also described in IEC 76 (1976) which are routine tests, type tests and special tests. One of the transformer measurements is using a TTR (Transformer Turn Ratio) measuring instrument. This is important for the correct prediction of the transformer condition. Therefore, this research was conducted to predict and assess the performance of the transformer, so as to minimize and prevent transformer failures that can harm many aspects. The operational feasibility of a power transformer can be determined after going through the stages of testing based on applicable standards. The reliability of the transformer during the operation period is largely determined by the way it is maintained, so that maintenance is needed for the reliability of the transformer [9-10].

The purpose of this research is to determine the ratio on the primary and secondary side of a 1000 KVA power transformer with a primary voltage of 20,000 Volt and a secondary 400 Volt using an Off Load Tap Changer, then observe and operate directly the use of the Raytech Transformer Turn Ratio comparison tool on the primary and secondary side of the transformer. 1000 KVA, resulting in comparisons between manual calculations using the Raytech Transformator Turn Ratio measuring instrument. The research output obtained is that the transformer secondary voltage error is known so that it can be analyzed the condition of the transformer itself which refers to the tolerance limits issued by IEEE C57.125.1991.

2. RESEARCH METHOD

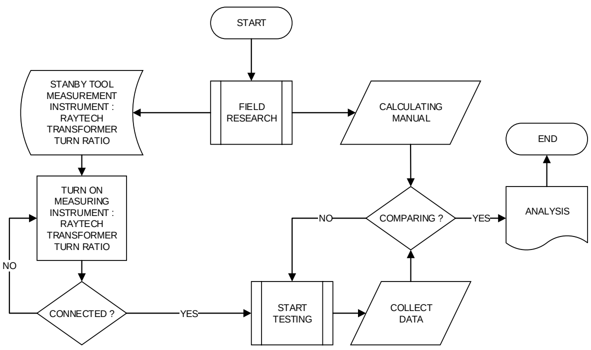

Figure 1. Flowchart design.

Figure 1 shows a schematic flowchart of the proposed research methodology. This test is carried out on the transformer in an off state (not on voltage) because it uses an off load tap changer by changing the tapping on the transformer and connecting the Raytech Transformer Turn Ratio gauge so that the ratio value data is obtained on the transformer. The output of the measuring instrument is then compared with a manual calculation so as to produce an analysis result of the measurement of a 1 x 1000 KVA transformer using the dyn-11 vector group and off load tap changer.

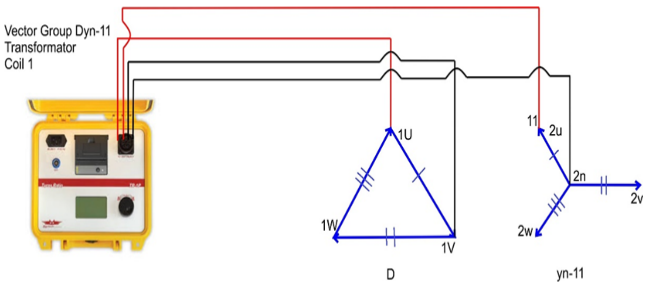

Figure 2. Installation of the Raytech Transformer Turn Ratio Connector to the Vector Group Dyn-11 on Coil 1 (Phase U).

Based on Figure 2 in order to obtain the comparison of the primary and secondary windings in the transformer, the first thing to prepare is the Raytech Transformator Turn Ratio measuring instrument. The Raytech Transformator Turn Ratio meter has four output connector cables where one red cable and one black cable for the primary side and one red cable and one black cable for the secondary side. It should be noted in the installation of the connector cable so that it is not arbitrary and must be adjusted to the Dyn-11 vector group on the transformer being tested, as shown in Figure 2.

Figure 2 shows the connection of coil 1 to the Raytech Transformator Turn Ratio gauge, on the primary side one red wire is connected to the root bushing (phase 1U), one black wire is connected to the root bushing (phase 1V). On the secondary side one red wire is connected to the root bushing (2u), one black wire is connected to the root bushing (2n).

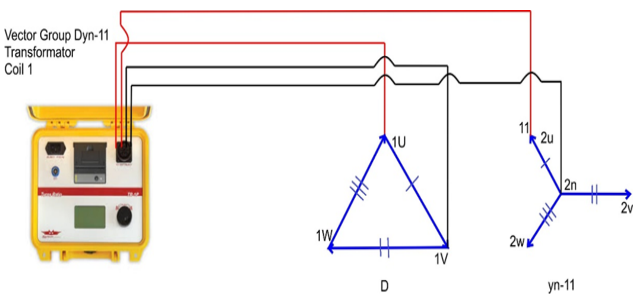

Figure 3. Installation of the Raytech Transformer Turn Ratio Connector to the Vector Group Dyn-11 on Coil 2 (Phase V).

Figure 3 shows the connection of coil 2 to the Raytech Transformator Turn Ratio gauge, on the primary side one red wire is connected to the root bushing (phase 1V), one black wire is connected to the root bushing (phase 1W). On the secondary side one red wire is connected to the root bushing (2v), one black wire is connected to the root bushing (2n).

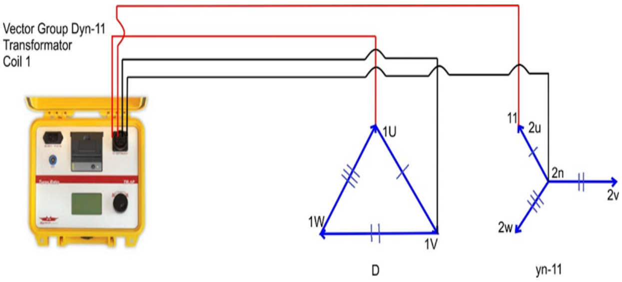

Figure 4. Installation of the Raytech Transformer Turn Ratio Connector to the Vector Group Dyn-11 on Coil 3 (Phase W).

Figure 4 shows the connection of coil 3 to the Raytech Transformator Turn Ratio gauge, on the primary side one red wire is connected to the root bushing (phase 1W), one black wire is connected to the root bushing (phase 1U). On the secondary side one red wire is connected to the root bushing (2w), one black wire is connected to the root bushing (2n).

From the test results using the Raytech Transformer Turn Ratio measuring instrument, the resulting data output is then compared with the following formula:

$$\frac{HVTap}{LV/\sqrt{3}} \qquad (1)$$

The result of Raytech Transformator Turn Ratio measurement is tolerated ± 0.5% of the dividing result using the formula. This tolerance reference is based on the IEEE C57.125.1991 standard. This tolerance is functioned so that the results of the Raytech Transformator Turn Ratio measurement have a maximum and minimum allowable ratio. A tolerance of 0.5% is characterized by the following calculation:

$$0.5\% = 0.005$$

$$1+0.005=1.005\,(\mathrm{Max}) \qquad (2)$$

$$1-0.005=0.995\,(\mathrm{Min})$$

3. RESULTS AND DISCUSSION

Figure 5. Raytech Transformer Turn Ratio Measurement Coil 1 (Left side - 5 times); Raytech Transformer Turn Ratio Measurement Coil 2 (Center side - 5 times); Raytech Transformer Turn Ratio Measurement Coil 3 (Right side - 5 times).

Figure 5 shows the results of measurements using the Raytech Transformator Turn Ratio measuring instrument which will then be recorded and analyzed after comparisons are obtained by performing manual calculations as shown in Eq. 3 – Eq. 7.

$$Tapping1 = \frac{HVTap}{LV/\sqrt{3}} = \frac{21000}{400/\sqrt{3}} = 90{,}93 \qquad (3)$$

$$Tapping1 = \frac{HVTap}{LV/\sqrt{3}} = \frac{20500}{400/\sqrt{3}} = 88{,}76 \qquad (4)$$

$$Tapping1 = \frac{HVTap}{LV/\sqrt{3}} = \frac{20000}{400/\sqrt{3}} = 86{,}60 \qquad (5)$$

$$Tapping1 = \frac{HVTap}{LV/\sqrt{3}} = \frac{19500}{400/\sqrt{3}} = 88{,}43 \qquad (6)$$

$$Tapping1 = \frac{HVTap}{LV/\sqrt{3}} = \frac{19000}{400/\sqrt{3}} = 88{,}27 \qquad (7)$$

$$Tolerance\_Tapping1\_\max = Eq.3 \times tolerance\_\max = 90.93 \times 1.005 = 91.38$$
(8)

$$Tolerance\_Tapping1\_\min = Eq.3 \times tolerance\_\min = 90.93 \times 0.995 = 90.48$$
(9)

$$Tolerance\_Tapping2\_\max = Eq.4 \times tolerance\_\max = 88.76 \times 1.005 = 89.20$$
(10)

$$Tolerance\_Tapping2\_\min = Eq.4 \times tolerance\_\min = 88.76 \times 0.995 = 88.32$$
(11)

$$Tolerance\_Tapping3\_\max = Eq.5 \times tolerance\_\max = 86.60 \times 1.005 = 87.03$$
(12)

$$Tolerance\_Tapping3\_\min = Eq.5 \times tolerance\_\min = 86.60 \times 0.995 = 86.17$$
(13)

$$Tolerance\_Tapping4\_\max = Eq.6 \times tolerance\_\max = 88.43 \times 1.005 = 84.85$$
(14)

$$Tolerance\_Tapping4\_\min = Eq.6 \times tolerance\_\min = 88.43 \times 0.995 = 84.01$$
(15)

$$Tolerance\_Tapping5\_\max = Eq.7 \times tolerance\_\max = 88.27 \times 1.005 = 82.68$$
(16)

$$Tolerance\_Tapping5\_\min = Eq.7 \times tolerance\_\min = 88.27 \times 0.995 = 81.86$$
(17)

Based on the results of the data that has been collected between the results of manual calculations and measurements using the Raytech Transformer Turn Ratio measuring instrument, it can be seen that the tolerance shown in Eq. 8 – Eq. 17. So that from the several steps that have been taken, starting from measurements using the Raytech Transformator Turn Ratio measuring instrument, followed by manual mathematical calculations until a tolerance value is obtained, finally it can be analyzed in this research as follows:

1. In winding measurement, the transformer ratio must be between the minimum and maximum values which have been set at 0.5% of the voltage ratio which refers to the IEEE C57.125.1991 standard. If the above measurement results do not match, then the transformer must be repaired by increasing or decreasing the winding on the primary side. If repairs are not done, one of the phases from the secondary side of the transformer can be lost so that the transformer coil is damaged and even damages the load e.g. equipment connected to transformers such as electric motors and so on, due to unbalanced voltages or those required by the load.
2. An error reading on the measuring instrument can cause a mismatch in the number of transformer turns. In the measurement results using the stipulated conditions, comparisons can be made with calculation analysis and also periodic calibration of measuring instruments.

4. CONCLUSION

After conducting the test and getting the test results using the Raytech Transformator Turn Ratio measuring instrument and comparisons using the formula, finally some final conclusions are obtained about the research that has been carried out, including comparison of the input / primary voltage winding of 20,000V and output / secondary voltage of 400V on a power transformer using a Raytech Transformator Turn Ratio measuring instrument with a voltage of 40VAC. Based on the comparisons of coils that have been done, it can be concluded, if the test results use the Raytech Transformer Turn Ratio measuring instrument, if it crosses the ± 0.5% limit, it can be seen that the measurement results of one of the coils have changed the ratio. The results of testing with the Raytech Transformator Turn Ratio measuring instrument that have been carried out are then compared with the manual formula calculation. If the Raytech Transformer Turn Ratio is not routinely checked on the transformer, it will result in an unbalance of voltage on one of the coils. And one of the coils in phase will expand and cause a loss of voltage (error) or cause damage to the load (other equipment) due to the unbalanced voltage. If the protective device used is in good condition, the protection device will strip the CB.

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