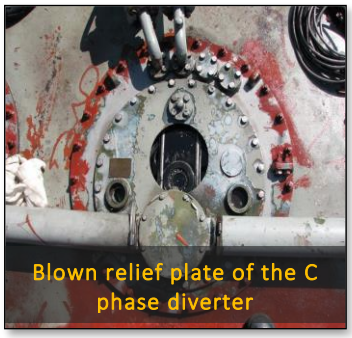
Case Study: SFRA the modern Crystal Ball

Preamble

On 19 February 2007, a 275/132 kV, 315 MVA 3 phase auto transformer, manufactured in 1982, tripped on differential protection (red and blue phases), main tank and tap change pressure. The tapchanger was made up of the selector residing in the main tank and diverters isolated in a partitioned compartment. The strategic importance of this transformer required decisive and prompt decision on the condition and suitable interventions. Congru engineers were requested to aid in this process.

Performance Scrutiny

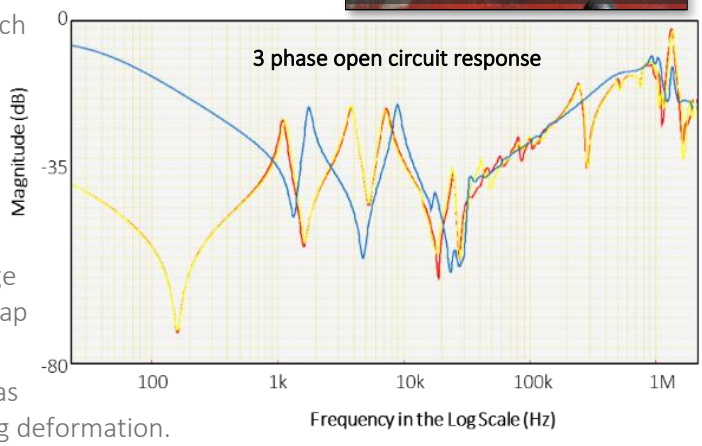
(For more information on our 5 Step Performance Scrutiny approach click on this link: https://congru.co.za/services)


Blown relief plate of the C phase diverter

Step 1: Purely from a visual inspection the fault caused a blowout of the pressure relief plate on the C phase diverter and the main tank pressure relief valve had operated. Damage to the diverter could damage the selector and more importantly the vulnerable tap windings. The condition of the other phases also needs to be checked.

Step 2: The key test was the SFRA which was performed on all phases and windings to ensure mechanical integrity. Also, all offline electrical test were also performed were possible.

Step 3: *Diagnostic*: An increase in power factor for all the winding which was expected. Exciting current revealed an increase of current on the C phase. The ratio measurements were also affected by the C phase diverter as expected. The SFRA revealed a short circuit which is attributed to the diverter and not the windings. What was of greater interest was the absence of resonant points of the C phase between 200kHz and 1MHz. Clear indications of winding deformation. Based on the damage to the diverter the conclusion can be drawn is that the tap winding could be deformed.

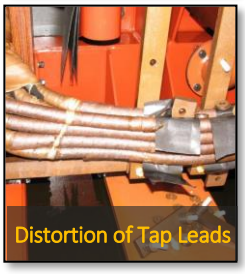


Predictive: The transformer cannot be returned to service as there is extensive damage to the diverter and possibly winding deformation.

Prescriptive: An internal inspection is required to determine the level of damage and to ascertain if repairs can be done on site or should the unit be sent to the factory for a detailed inspection and repair. The internal inspection must focus on the selectors for signs of damage, raptured barrier board between main tank and diverter compartment and the HV winding for deformation.


Damage to Selector

Step 4: The report revealed the findings from the electrical tests and external visual inspection. The key recommendations were the transformer cannot be returned to service, an internal inspection be performed and the transformer must be taken to the factory as there is concern that the tap winding may be deformed which will remain unsighted by an internal inspection.


Distortion of Tap Leads

Step 5: In summary the internal inspection matched the electrical tests to a great extent. There was not clear winding deformation for the HV winding. However, there were severe distortion of the tapping leads and numerous cleats were dislodged. There was evidence of a flashover on the C phase selector with damage to fixed contacts and collector ring. The fault most likely started on the selector and then caused the fault current to flow in the diverter and caused the flexible lead and potential straps burn off.

Epilogue

The customer was faced with a dilemma of either doing the necessary repairs onsite by replacing the selector and diverter of the C phase or sending the unit to the factory for a detailed inspection and repair. The former has two advantages in that it will be firstly significantly cheaper and secondly quicker to return to service. However, the customer had belief in the Congru technical team and opted to send the transformer to the factory for a detailed inspection. The detailed inspection revealed that the tap winding has suffered an axial collapse and needed to be rewound. If the customer had opted to perform onsite repairs the transformer would have suffered a catastrophic failure possibly on energisation which would have resulted in the increase in repair cost and longer delays. So SFRA was the saving grace by allowing us to visualize what we cannot see in this case the tap winding. The crystal ball!


Deformation of Tap Winding

If you have any questions or require more information, please contact our transformer specialist:
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