Comparison of Thermal Test Shutdown Techniques and Thermal Test Measurements on Three Phases
Comparison of Thermal Test Shutdown Techniques and Thermal Test Measurements on 3 Phases

This summary covers a series of thermal tests on a 3 phase padmount transformer to compare the winding rise results using:

- Present ANSI standard shutdown technique compared to restabilization of the top oil between resistance measurements.

- Measurement from one set of bushing connections compared to measurements between all bushing connections.

Testing was done on a 300 kVA padmount wye-wye 5-legged wound core transformer. The coils were of L-H construction with a wire primary and strip secondary. The short circuit (simulated loading) method of thermal testing was used. Computer control and data acquisition was utilized throughout the test series to take 8 resistance readings at about a 30 second interval. Testing was performed in the Engineering thermal Test and Development Lab at Waukesha WI.

<table>
<thead>
<tr>
<th>Table 1 – Description of Test Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Number: 0043XP10K65A</td>
</tr>
<tr>
<td>Serial Number: CP0550018222</td>
</tr>
<tr>
<td>Rated Winding Rise: 65</td>
</tr>
<tr>
<td>kVA: 300</td>
</tr>
<tr>
<td>Number of Phases: 3</td>
</tr>
<tr>
<td>Primary Phase Voltage: 7620</td>
</tr>
<tr>
<td>Secondary Phase Voltage: 208</td>
</tr>
<tr>
<td>Winding Losses @ Rated Tap: 3285</td>
</tr>
<tr>
<td>Core Losses: 766</td>
</tr>
<tr>
<td>Total Expected Losses: 4166</td>
</tr>
<tr>
<td>IZ: 2.47</td>
</tr>
</tbody>
</table>

Five shutdown techniques were compared. Testing was performed on the H1-H2 and X1-X2 bushing connections. Data
Test Methods

1. Present Std – Primary First - Full losses to Top Oil Stability; 50.4 °C TOR
   1-Hour Cutback to Rated Current;
   Primary Shutdown: 66.17 °C AWR
   1-Hour at Rated Current; Secondary Shutdown: 63.78 °C AWR

2. Present Std – Secondary First - Full losses to Top Oil Stability; 50.8°C TOR
   Secondary Shutdown: 63.79 °C AWR
   1-Hour Cutback to Rated Current;
   Primary Shutdown: 66.99 °C AWR

3. Proposed using rated current between measurements –
   Primary First - Full losses to Top Oil Stability; 50.05 °C TOR
   1-Hour Cutback to Rated Current; Primary Shutdown; 65.67 °C AWR
   Rated Current to Top Oil Stability; Secondary Shutdown; 63.26 °C TOR

4. Proposed using Total Losses – Primary First -
   Full losses to Top Oil Stability; 50.48 °C TOR
   1-Hour Cutback to Rated Current; Primary Shutdown; 65.65 °C AWR
   Full losses to Top Oil Stability; 50.48 °C TOR
   1-Hour Cutback to Rated Current; Secondary Shutdown 63.22 °C AWR

5. Proposed using Total Losses – Secondary First –
   Full losses to Top Oil Stability; 50.50 °C TOR
   1-Hour Cutback to Rated Current; Secondary Shutdown; 63.41 °C AWR
   Full losses to Top Oil Stability; 50.50 °C TOR
   1-Hour Cutback to Rated Current; Primary Shutdown; 65.46 °C AWR

Average and Standard Deviation for all tests
   Top Oil Stability; 50.45 °C TOR with a 0.27 °C SD
   Primary winding; 66.19 °C AWR with a 0.65 °C SD
   Secondary winding; 63.49 °C AWR with a 0.0.28 °C SD

Experimental Uncertainty of Test Equipment;
   Top Oil Stability; 1.35 °C
   Primary winding; 2.08 °C
   Secondary winding; 2.15 °C

Conclusions: The proposed changes in the heat run procedure to restabilize using total losses do not add any accuracy to the test results.
Testing to compare the winding rises for the 3 available connections to the primary and the secondary. All tests followed the present ANSI standard heat run method on the following connections:

Test 6 – Thermal tests on H1-H2 and X1-X2
   Full losses to Top Oil Stability; 50.80 °C TOR
   1-Hour Cutback to Rated Current;
   Primary Shutdown; 66.54 °C AWR
   1-Hour at Rated Current;
   Secondary Shutdown 64.14 °C AWR

Test 7 – Thermal tests on H2-H3 and X2-X3
   Full losses to Top Oil Stability; 50.85 °C TOR
   1-Hour Cutback to Rated Current;
   Primary Shutdown; 66.03 °C AWR
   1-Hour at Rated Current;
   Secondary Shutdown 63.01 °C AWR

Test 8 – Thermal tests on H3-H1 and X3-X1
   Full losses to Top Oil Stability; 51.25 °C TOR
   1-Hour Cutback to Rated Current;
   Primary Shutdown; 66.48 °C AWR
   1-Hour at Rated Current;
   Secondary Shutdown 63.88 °C AWR

Average and standard deviation for of tests 6, 7 and 8
   Top Oil Stability; 50.97 °C TOR with a 0.25 °C SD
   Primary winding; 66.35 °C with a 0.28 °C SD
   Secondary winding; 63.68 °C AWR with a 0.59 °C SD

Experimental Uncertainty of Test Equipment;
   Top Oil Stability; 1.35 °C
   Primary winding; 2.08 °C
   Secondary winding; 2.15 °C

Conclusions: The measurement of all bushing connections does not yield significantly different test results.