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

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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 1 – Description of Test Transformer

Catalog Number:	0043XP10K65A
Serial Number:	CP0550018222
Rated Winding Rise:	65
kVA:	300
Number of Phases:	3
Primary Phase Voltage:	7620
Secondary Phase Voltage:	208
Winding Losses @ Rated Tap:	3285
Core Losses:	766
Total Expected Losses	4166
IZ:	2.47

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 ^{O}C TOR
   1-Hour Cutback to Rated Current;
   Primary Shutdown: 66.17 ^{O}C AWR
   1-Hour at Rated Current; Secondary Shutdown: 63.78 ^{O}C AWR

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

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

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

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

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

Experimental Uncertainty of Test Equipment;
Top Oil Stability; 1.35 ^{O}C
Primary winding; 2.08 ^{O}C
Secondary winding; 2.15 ^{O}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 ^{O}C TOR
1-Hour Cutback to Rated Current;
Primary Shutdown; 66.54 ^{O}C AWR
1-Hour at Rated Current;
Secondary Shutdown 64.14 ^{O}C AWR

Test 7 – Thermal tests on H2-H3 and X2-X3

Full losses to Top Oil Stability; 50.85 ^{O}C TOR
1-Hour Cutback to Rated Current;
Primary Shutdown; 66.03 ^{O}C AWR
1-Hour at Rated Current;
Secondary Shutdown 63.01 ^{O}C AWR

Test 8 – Thermal tests on H3-H1 and X3-X1

Full losses to Top Oil Stability; 51.25 ^{O}C TOR
1-Hour Cutback to Rated Current;
Primary Shutdown; 66.48 ^{O}C AWR
1-Hour at Rated Current;
Secondary Shutdown 63.88 ^{O}C AWR

Average and standard deviation for of tests 6, 7 and 8

Top Oil Stability; 50.97 ^{O}C TOR with a 0.25 ^{O}C SD
Primary winding; 66.35 ^{O}C with a 0.28 ^{O}C SD
Secondary winding; 63.68 ^{O}C AWR with a 0.59 ^{O}C SD

Experimental Uncertainty of Test Equipment;

Top Oil Stability; 1.35 ^{O}C
Primary winding; 2.08 ^{O}C
Secondary winding; 2.15 ^{O}C

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