6.1.2.4 Interpretation of the transformer ratio test
Contributions and Comments

From Jeff Foley (8/20/09):

Discussion of exciting current as part of the turns ratio test

Most modern turns ratio test sets have a common set of features. These include a variable test voltage source and an ammeter / volt meter for measuring the exciting current as part of the turns ratio test. Historically, the older turns ratio bridges which operated with a hand crank, produced a voltage of 8 VAC. These devices included an analog meter for the exciting current, but offered no provision of measuring the actual current.

Since the measured excitation current is a function of the applied voltage and the non-linear magnetizing impedance of the transformer, useful comparisons of previous test results can only be made if the tests are performed at a consistent test voltage. It is therefore recommended that if the exciting current is recorded as part of the turns ratio test, the test voltage be recorded as well. Any future tests shall utilize the same test voltage.

Also from Paul Salvato (8/20/09):

Transformers with non standard phase shifts (not increments of 30°)
need 3 phase power to measure ratio and phase accurately

Excitation currents can be measured accurately with the modern test sets.
High excitation currents is indications of shorted turns or core problems.

Ratio readings can be different at different excitation voltages.

Ratio and excitation currents may be different when measuring with
a single phase crank at 8 volts and a electronic TTR meter.

From Jeff Foley (9/15/09):

3. Excitation current (why?) once we agree on what to call it, we need to describe what is learned by observing and recording these currents (Jeff Foley and Steve Metz)

The reasons for observing and recording the excitation currents are very similar to those using a 10kV source. The difference being that a 10 kV excitation test is not always specified as part of a routine test, or it may be that the equipment may not be available. This is particularly useful in detecting inter turn faults. (see attached article)

4. Connection Chart – a connection chart is needed showing connections of known winding configurations (Paul Salvato and Jeff Foley)

6.1.2.4 Interpretation of the transformer ratio test Contributions and Comments

IEC 60076 vector group	Winding HV/H	Winding LV/X	red	black	red	black	TRRatio settings Vprim	Vsec
Dd0			U/H1	V/H2	u/X1	v/X2	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	v/X2	w/X3		
			W/H3	U/H1	w/X3	u/X1		
Yy0			U/H1	V/H2	u/X1	v/X2	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	v/X2	w/X3		
			W/H3	U/H1	w/X3	u/X1		
Dz0			U/H1	V/H2	u/X1	v/X2	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	v/X2	w/X3		
			W/H3	U/H1	w/X3	u/X1		
Dy5			U/H1	V/H2	n/X0	u/X1	☐ 1/√3	☑ 1/√3
			V/H2	W/H3	n/X0	v/X2		
			W/H3	U/H1	n/X0	w/X3		
Yd5			U/H1	N/H0	w/X3	u/X1	☑ 1/√3	☐ 1/√3
			V/H2	N/H0	u/X1	v/X2		
			W/H3	N/H0	v/X2	w/X3		
Yz5			U/H1	V/H2	n/X0	u/X1	☐ 1/√3	☑ 1/√3
			V/H2	W/H3	n/X0	v/X2		
			W/H3	U/H1	n/X0	w/X3		

IEC 60076 vector group	Winding HV/H	Winding LV/X	red	black	red	black	TRRatio settings Vprim	Vsec
Dd6			U/H1	V/H2	v/X2	u/X1	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	w/X3	v/X2		
			W/H3	U/H1	u/X1	w/X3		
Yy6			U/H1	V/H2	v/X2	u/X1	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	w/X3	v/X2		
			W/H3	U/H1	u/X1	w/X3		
Dz6			U/H1	V/H2	v/X2	u/X1	☐ 1/√3	☐ 1/√3
			V/H2	W/H3	w/X3	v/X2		
			W/H3	U/H1	u/X1	w/X3		
Dy11			U/H1	V/H2	u/X1	n/X0	☐ 1/√3	☑ 1/√3
			V/H2	W/H3	v/X2	n/X0		
			W/H3	U/H1	w/X3	n/X0		
Yd11			U/H1	N/H0	u/X1	w/X3	☑ 1/√3	☐ 1/√3
			V/H2	N/H0	v/X2	u/X1		
			W/H3	N/H0	w/X3	v/X2		
Yz11			U/H1	V/H2	u/X1	n/X0	☐ 1/√3	☑ 1/√3
			V/H2	W/H3	v/X2	n/X0		
			W/H3	U/H1	w/X3	n/X0		

5. Single phase crank - advantages and disadvantages of this test method (Steve Metz and anyone else who has experiences)

The advantage of using a hand cranked ratio bridge is that it provides a tactile feedback to the user. If a winding of a transformer has a problem (when compared to the others) a noticeably higher degree of effort will be required to perform the test. This in itself may provide the user an indication that further investigation is required.

7. Transformers with phase shifts between primary and secondary other than multiples of 30 degrees (like phase shifters, unsymmetrical ZigZag, multiple phase transformers etc.) - we need recommendations for making measurements on these transformers (Jeff Foley and Paul Salvato and anyone else with experiences)

One method of measuring such transformers is to utilize a suitable 3 phase (regulated) source, such as a modern relay test. With applicable measuring equipment (HV/LV Voltages / currents / phase angles) these tests can be accomplished.

From Paul Salvato (9/15/09):

Attached is the connections in excel.

I want to confirm the equations, but this is the primary information regarding connections for testing. The equations would be for the results analysis section. They are for calculating the difference between turns ratio and voltage ratio for the different configurations. All measurements are done in voltage ratio, and turns ratio are calculated.