

AGENDA

WG - Guide for Transformer Paralleling

Monday, April 19, 2009 3:15 – 4:30

- 1) Introductions – Circulation of roster – Patent Issues**
- 2) Approve Fall '08 Meeting Minutes (Attached)**
- 3) Review of PAR (Introduction section of guide?)**
- 4) Review “Comments for Discussion” – Sanjib Som (Attached)**
- 5) Discuss general format for guide sections /subsections &
Progress Reports: See Guide General Outline below.**
- 6) Section development – volunteers / re-assignments**
- 7) New Business**

P57.153 Guide for Transformer Paralleling – Meeting minutes – Oct. 6, 2008

- * The working group met with 8 members and 9 guests in attendance. The minutes from the last meeting were approved and no patent issues were identified.
- * The group reviewed the Scope and Purpose as shown in the newly approved PAR. BASICALLY, this paralleling guide describes and compares **control** methods of paralleling power transformers **equipped with load tap changers (LTC) or series regulators**.
- * The group reviewed the 3 major premises of transformer paralleling: (1) maintaining the basic function of voltage control, (2) to minimize circulating or difference currents, and (3) automatically operate correctly regardless of system configuration changes.
- * We discussed a definition of “Paralleled Transformers”. 3 options were discussed with the preferred one being:
“Two or more transformers connected in such a manner that they share in supplying power to a common load bus.”
- * The group reviewed and discussed the automatic operations of several substation and system configurations. Discussions included how these varied conditions create different control configurations which need to be made automatically.
- * The several names given to paralleling control methods were discussed and proposed “preferred” names were listed.
- * Two possible system questions to determine the need for paralleling equipment or this guide were discussed.
 - 1) Will **ANY** system condition cause this transformer to be in parallel with another? (IF YES)
 - 2) Will **ALL** system conditions cause “tap difference” **control** voltages to create paralleling self correction? (IF NO)
- THEN:** It will require parallel equipment (master follower, circulating current, negative reactance, var balancing or power factor – other?)
- * We reviewed the CEMA paralleling standards which included master/follower and circulating current. More information from CIGRE standards will be discussed at the next meeting.
- * The Guide’s general outline and the section outlines were briefly reviewed with a call for members to choose a subsection to discuss and do so. We will hopefully have sections sent to members and guests for comments in the coming months.

The meeting was adjourned at 5:30pm.

Guide General Outline

I. Introduction Tom Jauch (10/08)

DEFINITION OF PARALELLING – Jim Graham (1/28/08) COMPLETE

REASONS FOR PARALLELING TRANSFORMERS - Carlo Arpino (3/08)

Describe the need for independent/paralleling operation strategies (load balancing)

Describe the tapchanger control/paralleling strategy relationship (setpoint biasing)

Describe the methods of providing paralleling strategies

Describe the special paralleling system application consideration Sanjib Som - (3/08)

Describe the special transformer/regulator equipment application considerations

Provide “typical problem” (FAQ) information

Provide commissioning or troubleshooting suggestions

Provide a method vs applicability chart

Provide a bibliography of available printed information

II. General Overview of Transformer Paralleling Requirements:

Transformers designed for paralleling – Dave Harris (3/08)

(LTC) Load Tap Changer transformers

- Single Phase / Three Phase Transformers

Non-LTC Transformer /Regulator combination

- Single Phase / Three Phase Transformers/regulators

III. Basic Tapchanger Control: Tom Jauch (10/08)

IV. Basic Paralleling Method Descriptions/Applications/Equipment Interconnection:

MASTER / FOLLOWER – Dave Harris (10/28/07)

CIRCULATING CURRENT– Carlo Arpino, Jim Harlow (3/08)

CIRCULATING REACTIVE CURRENT– Tom Jauch (10/3/08)

NEGATIVE REACTANCE – Mark Tostrud (10/17/07)

POWER FACTOR – Jim Harlow, Carlo Arpino (3/08)

Guide Subsections

Method (M/F; NR; CC; VB; PF)

- 1) Operating Principles
- 2) Equipment – Purpose and Connections
- 3) Settings / Sensitivity
- 4) Multiple Transformer Applications
- 5) Effects of Non-similar Transformers
- 6) Backup Methods
- 7) Non-applicable system configurations / applications
- 8) Most Frequent Application Errors – Solutions
- 9) Commissioning / Troubleshooting suggestions
- 10) Conclusions:

V. Special Transformer Application Considerations:

Unequal ratings and/or impedances

AutoTransformers / Step-down transformers

Multiple winding transformers

- Multiple secondary windings / Tertiary windings

Dissimilar winding arrangements

- High side / Low side taps

- High / Low loss units – X/R ratio?

Paralleling LTC with a non-LTC transformer (fixed ratio)

Paralleling with transformer+regulator – Kiran Vedante(1/24/08)

VI. Special System Application Considerations:

Multiple parallel units

Coordination with Line Drop Compensation (LDC)

Multiple source stations

Ring bus(+)applications(primary /secondary)

High side isolation

System X/R ratio effects

Network application

Power Reversal

Transmission-Tie applications

Remote source system breaker operation effects

VII. Load bus separation impedance effects:

Distance (impedance) between units

Current limiting reactor applications

VIII. Backup protection:

IX. Typical problems:

X. Field commissioning / troubleshooting:

XI. Conclusions

COMMENTS FOR DISCUSSION from Sanjib Som

I am listing below some points which I feel should find a place in this guide.

- 1) The two or more transformers being parallel must have identical turn ratio and BIL capability at both input and output terminal; it is not necessary that they have the same voltage ratio.
- 2) If the transformers are three phase they must have identical phase sequence.
- 3) When the kVA rating is identical, the impedance at all taps must be within 10% of the lower impedance of the two transformers. When the kVA are not equal then the impedance must be inversely proportional to the kVA rating, the tolerance is again $\pm 10\%$. This condition is applicable at all taps of operation. This will allow loading upto about 90% of full rating for the transformer which is least loaded.

When purchases request a new transformer suitable for parallel operation they must clearly state whether it is for parallel operation with existing transformer or for parallel operation with another transformer being purchased in same order.

When the requirement is for parallel operation with an existing transformer the purchaser must specify the following

- a) The voltage ratio of the existing transformer.
- b) The BIL of each terminal.
- c) The tap voltage on all terminals with respect to DETC and/or LTC as applicable.
- d) The vector group in case of three phase transformer. If it is an autotransformer, this must be clearly stated because different manufacturer may have different practice for internal clearance.
- e) Impedance at nominal tap and extreme taps both for DETC and LTC positions. This is required for properly location the tap section and/or tap coil in the suitable location of the magnetic field.
- f) Requirement, if any, that the existing transformer be a mirror image is to be stated.
- g) Requirement, if any, of any limiting dimension or specific radiator or LTC location is also to be stated.
- h) Requirement of specific make of bushing, arrestors and termination type is to be stated in the specification, if applicable.
- i) Color shade of existing unit and requirement of color matching is to be stated if required.
- j) The auxiliary voltage supply to be used for paralleling operation.
- k) LDC CT ratio on existing transformer and any requirement on the new transformer.
- l) Any specific requirement of LTC make or type, paralleling module and maintenance requirement must be stated.
- m) If the transformer will be connected to vacuum circuit breaker this must be stated so that the transformer manufacturer may be able to take precaution in design against high frequency multiple surges associated with vacuum breakers.
- n) Any limitation on auxiliary load of new transformer so that existing capacity is not exceeded.

Thanks and Regards,