T&D General Systems Subcommittee

Practical Aspects of Ferroresonance WG

Minneapolis, Minnesota, MCC – 208 A

Tuesday, July 27, 2010

8:30-10:00 am

Meeting Minutes

Participants:

David Jacobson	dajacobson@hydro.mb.ca
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Lubomir Kocis	kocis@egu-vvn.cz
Francisco de Leon	fdeleon@poly.edu
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Jeff Laninga	jlaninga@hydro.mb.ca

Working Group Officers:

Bruce Mork, Michigan Tech University, is the chair of the WG. David Jacobson, Manitoba Hydro, is co-chair and secretary.

Discussion:

- The terms of reference and purpose of group was reviewed for new attendees.
- Attendees introduced themselves and areas of expertise/interest.
- The minutes from the 2009 WG meeting in Calgary were reviewed and accepted. Minutes and working group documents can be downloaded from: http://www.ece.mtu.edu/faculty/bamork/FR_WG/
- A General Systems Subcommittee website is being created by Brian Johnson and will be modified to include a link to the above website. The existing website is out-of-date (last updated in 2005): http://grouper.ieee.org/groups/td/gensys/

- **CIGRE collaboration**
  - A new Cigre working group C4.307 was formed in March 2010. The Terms of Reference is attached. The focus is mainly on transformer energization studies including both resonance and ferroresonance aspects. Lubomir presented the results so far and a plan for report completion.
  - Michel Rioual and David Jacobson will monitor this development and act as liasons to ensure coordination.

- **Working Group document – Status and plan development**

- David Jacobson gave a status report on the document. All contributions received to date have been converted to Word and included in the Technical Brochure. There are a number of areas where additional information is required. A summary of the main actions is included below. Contributions are due by the end of October.
- David will incorporate the contributions into the main document and circulate the chapters to the core working group members: David Jacobson, Bruce Mork, Michel Rioual, Reigh Walling and Juan Martinez for review by December.
- Bruce will organize a series of webex conference calls to gather final comments on each chapter in early fall.
- Consideration will be given to circulate the document to everyone on the ferroresonant WG e-mail exploder for review and comments.
- Final approval of the document may be done by e-mail or at the July 2011 IEEE GM.

WG Special Publication assignments

- Executive Summary – Bruce Mork/David/Michel/Reigh/Juan
- 1. Introduction
  - What is Ferroresonance? – Bruce Mork
  - How does it impact us?-Bruce Mork
  - Typical Waveforms and Overvoltages-Bruce/David/Michel/Reigh
  - Nonlinear Behaviour, bifurcations-Decide to Remove- David Jacobson
- 2. Summary of Ferroresonance Literature
  - Historical Background & Major Milestones - Remove nonlinear dynamics references and simplify - David
  - Basic Circuit Types Susceptible to Ferroresonance-David Jacobson/Juan/Michel
  - Literature summary of distribution systems-David will review the references in Reigh Wallings and IEEE Slow transients papers and include here.
  - Basic Mitigation Techniques-David Jacobson
- 3. Catalog of Ferroresonance Scenarios and Mitigation
  - Distribution Systems (< 60 kV)
    - Ferroresonance in Low-Loss Distribution transformers-Reigh Walling
    - Interaction between Arresters and Transformers during Ferroresonance- Reigh Walling
    - Cost of Mitigation Options- Mort Knodaie
  - Transmission Systems (> 60 kV)
    - 345 kV VT/grading capacitor- Bruce Mork
    - Transformer Terminated Double-Circuit Line-David Jacobson

        - Practical guidelines on line length and short circuit level to avoid quasi-periodic oscillations-Michel Rioual/Kieny
    - Summary: Engineering Forensics, Identifying Ferroresonance, Symptoms, Damage-David/Bruce
- 4. Catalog of Scenarios Commonly Confused with Ferroresonance
    - TOV Summary-Bruce Mork/David Jacobson
      Refer to types described in IEEE TOV task force report, 1990 Cigre paper 33-210
    - EDF TOV Example (add mitigation discussion)-Michel Riouale
    - Voltage Magnification (cap bank switching)-Bruce
    - Sustained Harmonic Inrush-Bruce Mork
    - Shunt reactor resonance-David Jacobson
    - Switch Restriking-Jeff Laninga
    - Misinformation in the literature-Bruce Mork (e.g. Wikipedia)
- 5. Introduction to Modeling for Ferroresonance Studies
    - Add parameter determination and references (D. Jacobson questions)-Juan Martinez
    - Expand section on Hysteresis modeling-Afshin Rezaei-Zare
    - Include key points from low frequency modeling chapter (TP-133-0)-David
        - What parts of the network are critical to model (e.g. losses, stray capacitance/cable capacitance, transformer impedance and saturation)
        - Are there simple rules of thumb? - Michel
    - Simulation Tools (compare PSCAD/EMTP on benchmark cases)-Bruce/Juan/Pei Wang
    - Model Parameters –Bruce/Juan
        - Where do parameters come from?
        - Are special transformer tests needed (e.g. inrush test)?
        - How should losses be measured?
    - Introduction to Advanced Modeling (optional)
        - Duality based modeling-Juan Martinez
        - Iron-core loss modeling-Noel Janssens
- 6. Conclusions
  Should include general recommendations on preferred connections, operating strategies, how to avoid ferroresonance in the design stage or mitigate. The cost of mitigation could be included.
  David/Bruce/Michel/Reigh/Juan
- 7. Appendix
    - Ferroresonance Literature Review (Update to include recent reference additions)-David Jacobson

- **New Task Force Proposals**
  - The plan is to continue with a working group focusing on practical applications. Proposals are asked for a new Task Force to investigate and report on more theoretical research in the field.

- **Technical Presentations**

  - Mr. Noda presented experience from Japan. Most ferroresonance problems were solved more than 20 years but issues are arising today because experienced engineers are retiring. The system is evolving to use single phase reclosers being manufactured, single phase breakers being used on distribution systems. Some amorphous core transformers are being used as well.