

T&D General Systems Subcommittee  
Practical Aspects of Ferroresonance WG  
Calgary, Alberta, Fairmont, Room Oval  
Wednesday, July 29, 2009, 8:30-10:00

## Meeting Minutes

### Participants:

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### 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 minutes from the 2008 WG meeting in Pittsburg were reviewed and accepted.
- Minutes and working group documents can be downloaded from: [http://www.ece.mtu.edu/faculty/bamork/FR\\_WG/](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 The existing website is out-of-date: <http://grouper.ieee.org/groups/td/gensys/>
- **CIGRE collaboration**
  - Cigre WG C4.301 is putting together a document on insulation coordination and lightning arresters. Lubomir Kocis (Head of R&D, EGU HV Lab, Czech Republic, [kocis@egu-vvn.cz] ) was leading the writing of a section related to ferroresonance. This work will be moved to its own working group. Study committee C4 is in the process of writing the Terms of Reference. Michel thought the direction of the new working group may be more related to transformer energization but ideally it should be related to impacts of ferroresonance on insulation coordination and lightning arrester selection.

- Michel Rioual and David Jacobson will monitor this development and act as liasons to ensure coordination.
- **Working Group document**
  - 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 2009.
  - 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 2009.
  - Bruce will organize a series of webex conference calls to gather final comments on each chapter in early 2010.
  - 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 2010 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

- **Technical Presentations**
  - Afshin presented information from his PhD research related to the significance of including accurate modeling of hysteresis for ferroresonance studies.
  - Afshin will provide a writeup for inclusion in the modeling chapter of the working group document.
  
- **Notes from July 29 General Systems Subcommittee meeting**
  - The General Systems Subcommittee meeting was cancelled.
  - Bruce and David will develop and provide the Terms of Reference for the proposed new task forces to Albert Keri later this fall.