T&D General Systems Subcommittee

Practical Aspects of Ferroresonance WG

Tampa, Florida, Convention Center, Room 32

Tuesday, June 26, 2007, 10:00-12:00

Meeting Minutes

Participants:

David Jacobson	dajacobson@hydro.mb.ca
Bruce Mork	bamork@mtu.edu
Michel Rioual	michel.rioual@edf.fr
Juan A. Martinez	martinez@ee.upc.edu
Albert Keri	ajkeri@aep.com
Mort Knodaie	mknodai@pnm.com
Lucas Collette	Lucas.Collette@meppi.com
Reigh Walling	
Jean Mahserejian	

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 2006 WG meeting in Montreal 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.

- **Working Group document**
    - David Jacobson gave a status report on the document:
    - Introduction – 60% complete. Material from the “Understanding and Dealing with Ferroresonance” document from Bruce Mork will be merged to complete the introduction. We could consider some of the Cigre info for part of the introduction.
    - Detailed summary of literature search – 80% complete. A volunteer was asked for at the last meeting to write a summary of the salient points from the literature that relate to distribution systems. Dan Durback was going ask Dave Smith. Bruce will follow up with Dan to see if this is possible.
    - Catalog of Ferroresonance scenarios – 50% complete. Case studies have been received from Roger Dugan, Fransisco de la Rosa, Gene Lindholm, Patrick Picher and David Jacobson. Need remaining contributions from Mort Knodaie, Todd Sarkinen, Bruce

Mork, Albert Keri, David Jacobson and Michel Rioual. David needs a word file of Reigh Wallings 2003 panel paper.

- Things that are not Ferroresonance – 10%. Case study received from Michel Rioual. Need remaining contributions from Bruce Mork and David Jacobson.
- Introduction to Modeling, simulation and parameters – 70%. David received a Framemaker file of the low frequency transients chapter (TP-133-0) from Ani Gole. Juan provided a draft of the chapter in Word. Some work is needed to merge the two documents and possibly add some case studies discussing modeling points. David will merge the documents.
- Appendix – literature review – 95%. The annotated bibliography is substantially complete. A few references may be added to bring the document up to date.

- Proposed Work plan
- **CIGRE collaboration**
  - Cigre WG C4.301 is putting together a document on insulation coordination and lightning arresters. Lubomir is leading the writing of a section related to ferroresonance. The direction of the work right now has a fair bit of overlap with our work. However, they are in the beginning stages.
  - The group decided that we were too far along to develop a joint Cigre/IEEE document. It is preferable to invite the Cigre WG to participate in our document. Bruce/David will formally invite the participation.
  - We have several examples that could be used to assist with the Cigre document. For example, David has an example where 500 kV arrester energy level was specified to withstand ferroresonance following a breaker fail. Reigh Walling has an example where the arrester was heavily involved in the ferroresonance oscillations. Thirty seconds of exposure was o.k. However, prolonged exposure resulted in the surge arrester temperature exceeding 250C, which changed the characteristics of the arrester. This phenomena is not addressed in the IEC standards.
  - Do we merge our work with the Cigre Working Group? Extra bodies would help but document approvals might take longer.
  - The plan is to focus on the WG document and have it complete by the next meeting in Pittsburg.
    - September 15, 2007 – David will send out a PDF file of the document with contributions received to date
    - October 31, 2007 – deadline for sending in major contributions from working group members: e.g. Case study contributions and “things that are not ferroresonance”
    - December 15, 2007 – David will send out a revised PDF file with the new contributions.

        - February 28, 2008 – deadline for comments and any remaining contributions
        - June 2008 – Final draft will be posted for comments.

- **Notes from General Systems Subcommittee meeting**
    - Working group document is planned on being published as an IEEE special publication in 2007.
    - A panel session or tutorial will be prepared for the 2008 General meeting. A tutorial requires at least one year advance notice. The panel session could be organized to be of a tutorial nature, which wouldn't require as much advance notice for IEEE. The "Development, Experiences and Applications of GIS, GIL and SF6 in Power Systems" panel session was run in this format in Montreal quite effectively.
    - A new name for the working group might be more effective as there are plans to expand the scope of the group to tackle advanced methods of ferroresonance analysis.
        - Proposed change to IEEE Ferroresonance WG with two task forces: TF on Practical Aspects of Ferroresonance, TF on Advanced Methods of Ferroresonance Analysis.
        - A name change needs to be submitted by the chair of the General Systems Subcommittee (Reza Iravani) and voted on by the T&D Committee. Task forces can be created by the WG chairs without approval from the SC chair.
        - David and Bruce will discuss the changes further and discuss with the Working Group. A decision should be made prior to December 2006 in case organization changes are desired for the General meeting in Tampa.
    - The meeting time of the WG was discussed. The current time of 10-12 on Tuesday causes conflict for some members who are participating in other distributed generation groups. A proposal was made to move the General Systems Subcommittee meeting to Wednesday at 5-6 pm. Wednesday afternoon may be a possibility for the ferroresonance meetings. Bruce is working on the Power Globe WG from 1:30-2:30. Perhaps 2:30-3:30 for TF on Advanced Methods of Ferroresonance Analysis and 3:30-5:00 for a joint meeting TF on Practical Aspects/IEEE Ferro WG might work. Bruce and David will discuss and propose a time to Reza Iravani.

WG Special Publication assignments

- Foreward/Executive Summary – Bruce Mork/David

- Introduction
  - What is Ferroresonance? – David Jacobson/Bruce Mork
  - How does it impact us?-Bruce Mork
  - Typical Waveforms and Overvoltages-Bruce/David
  - Nonlinear Behaviour, bifurcations-David Jacobson
- Detailed Summary of Literature Search
  - Historical Background & Major Milestones -David Jacobson
  - Basic Circuit Types Susceptible to Ferroresonance-David Jacobson
    - Literature summary of distribution systems-Dan Durback/David Smith
  - Basic Mitigation Techniques-David Jacobson
- Catalog of Ferroresonance Scenarios and Mitigation
  - Distribution Systems (< 60 kV)
    - Examples of Ferroresonance-Roger Dugan
    - Ferroresonance in Low-Loss Distribution transformers-Reigh Walling
    - Ferroresonance in a Cable Fed transformer- Francisco De La Rosa
    - Ungrounded delta tertiary – Gary Kobet
    - Case Studies – Gene Lindholm
    - Amtrack rail – Dan Durback
    - Cost of Mitigation Options- Mort Knodaie
  - Transmission Systems (> 60 kV)
    - Open-Delta PT-David Jacobson
    - 230 kV Transformer/grading capacitor-David Jacobson
    - 345 kV VT/grading capacitor-Todd Sarkinen or Bruce Mork
    - Transformer Terminated Double-Circuit Line-David Jacobson and Albert Keri
    - Capacitor Voltage Transformer-David Jacobson
    - Energize 400 kV transformer from isolated generator. 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
- Things that are NOT 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-Michel Riouale
  - Voltage Magnification (cap bank switching)-Bruce
  - Sustained Harmonic Inrush-Bruce Mork/Roger Dugen
  - Shunt reactor resonance-David Jacobson
  - Switch Restriking-David Jacobson
  - Misinformation in the literature-Bruce Mork
- Introduction to Modeling, Simulation, Parameters
  - Introduction to ferroresonance modelling-Bruce Mork/Juan Martinez

        - 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)
    - Simulation Tools-Bruce Mork
    - 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
- 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
- Appendices
    - Ferroresonance Literature Review-David Jacobson