

Meeting Minutes
IEEE / PES Transformers Committee
Performance Characteristics Subcommittee
TF to Investigate the Interaction between Substation Transients
and Transformers in HV and EHV Applications
Atlanta, Georgia
Tuesday, March 22nd, 2016
3:15 PM – 4:30 PM
Capitol North
Chairman – Jim McBride
Secretary – Tom Melle

- 1) Welcome and Chair's introductory remarks.
- 2) Circulation of Attendance Sheets
- 3) There were 127 individuals in attendance with 28 members present.
Quorum was achieved.
- 4) Fall 2015 Meeting Minutes presented and approved with no opposition
- 5) Spring 2016 Agenda presented and approved with no opposition
- 6) Chair mentioned the summary paper will be posted to the TF website. Sue McNelly did so immediately. Thank you Sue!
- 7) Chair began presentation and discussion of three primary issues from the Fall 2015 meeting. All three issues are addressed in the latest revision of the TF summary paper:
 - I. The Chair presented a few example traces of a three phase capacitor switching transient from the TF paper, noting that capacitor switching can produce three types of interactions. Simple LC interaction, back to back interaction, and traveling waves with reflections. The second two were most likely to excite lightly loaded transformers to resonance.
 - a) Phil Hopkinson suggested that (whenever possible) current measurements and traces from all three phases be included in the paper. Chair was not opposed to this, but no motions were made to make changes to the TF summary paper.
 - b) The example oscillations presented ranged from 1.1 kHz (base) to 52 kHz.
 - c) Waldemar Ziomek commented that phases A & C are opposite polarity due to transformer interaction and reflection of waves

The chair also showed a trace of an energization transient which had a much higher frequency voltage waveform. Approximately a 500ns rise with a 580 kHz ring.

- II. Mitigation Methods - Chair reviewed the mitigation sections of each of the failure categories in the TF summary paper. Chair commented that RC snubbers are not commonly used on HV/EHV circuits. Phil Hopkinson agreed it is difficult to mitigate transients at higher voltages with snubbers and supports capacitor use as a mitigation tool. It was noted that special emphasis should be applied whenever possible to monitor and mitigate high frequency transients.
 - a) Pierre Riffon made a motion for the TF paper to include additional impulse testing as a possible mitigation method (e.g. non-impulsed windings are typically shorted to ground in the factory – suggest “real world” shorting using simulated impedance of system during test). Motion was seconded by Waldemar Ziomek and passed with no objections.

- III. Chair explained the separation of Conclusions and Recommendations sections in the paper. Chair stated that the TF paper is nearly finalized and must undergo review for IEEE Transactions submission. Ideally the paper will be utilized in an upcoming Committee tutorial.
 - a) Phil Hopkinson inquired regarding the duration of magnetization current and relationship to core saturation. Comments were received stating the more likely contributors to failure are series resonant voltage, air core inductance, and leakage flux. Phil asked if the TF paper should describe these resonant interactions that cause failures. The Chair pointed out that this interaction as a failure mode is included in the GSU back feed section of the paper, noting that generator step-up transformers operating in back feed mode may be excited to resonance by system transients.
 - b) Bertrand Poulin commented that the low frequency response of transformers is easier to model; as high frequency response requires a more detailed model. Chair added that CIGRE continues to develop “white-box” transformer models, but measurements are needed in order to validate these models. Bertrand commented further on the importance of measuring the magnitude of the transient voltage at the transformer terminal – given this

information, “it is imperative that manufactures design transformers with necessary immunity”.

- c) Phil Hopkinson commented on Figure 4 (Disconnect Switch Bus De-Energization Transient) that re-striking can last up to several seconds, leading to many consecutive restrikes per disconnect operation. Chair agreed and commented that although restrikes during closing operations are generally much shorter, these closing operations may also excite internal resonance due to multiple re-ignitions and re-strikes.
 - d) Vijay Tendulkar commented that core saturation is dependent upon total circuit impedance and that very different conditions can arise in differing circuits from the same voltage transient.
- 8) Motion for Task Force to move forward with submission of the paper to IEEE made by Sanjib Som. Motion was seconded by Phil Hopkinson with no objections.
- 9) New Business – none presented
- 10) A motion to adjourn the meeting was made by Pierre Riffon and seconded by Bertrand Poulin. The meeting was adjourned at 4:15 PM.

Respectfully Submitted,
Tom Melle, TF Secretary
03/22/2016