

Special Studies - Classical Studies

Classical Studies

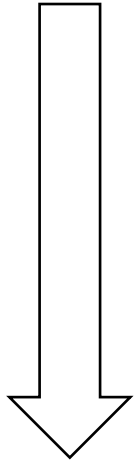
- “Traditional” EMT Studies:
 - TOVs, Line Design and Insulation Coordination
 - Energize lines, cables, transformers, shunt capacitors
 - Faults and recovery TOVs
 - Rating and Performance studies
 - Lightning
 - TRV
 - & more..

Good resource (one of many):

https://www.pscad.com/uploads/knowledge_base/application_20guide_202008_1.pdf

Study Techniques

Time Step



- Steady State
- Long Duration Time Domain Analysis
- Transient Stability Dynamic Performance
- EMT Dynamic Performance
- TOV and Switching Transients
- TRV and Lightning

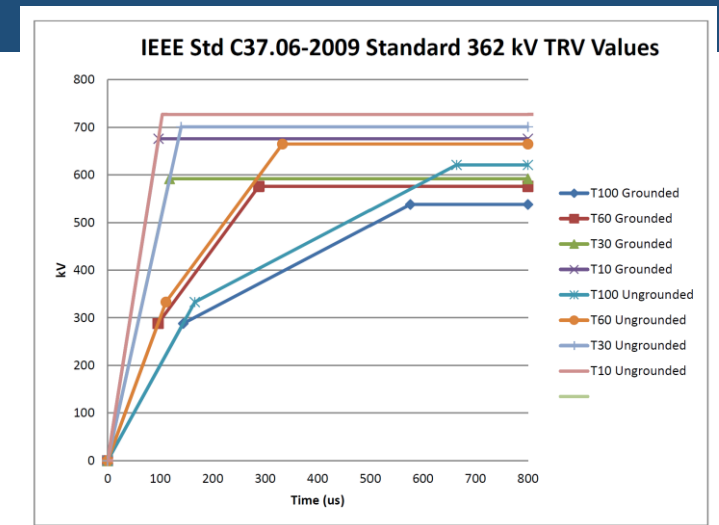
Lightning Studies – fast front transients

- Study objective: Determine impact of lightning strikes, i.e. is shield wire / surge arrester / insulation design sufficient to avoid damage to equipment
- Very fast lightning current surges (50-100 μ s duration) striking either conductors or ground wires / tower
 - Direct strike on conductor: risk of exceeding arrester / insulation levels, flashover risk
 - Strike on tower: risk of voltage build-up on tower exceeding insulation level (back flash-over)
- Important modelling details and assumptions:
 - Ultra small time-step (nsec)
 - Surge shape
 - Stray capacitance
 - Lead inductance
 - Grounding/shielding
 - Tower modelling
 - Steep front arrester models
- Mitigation:
 - More surge arrestors, more grounding, more shield wires

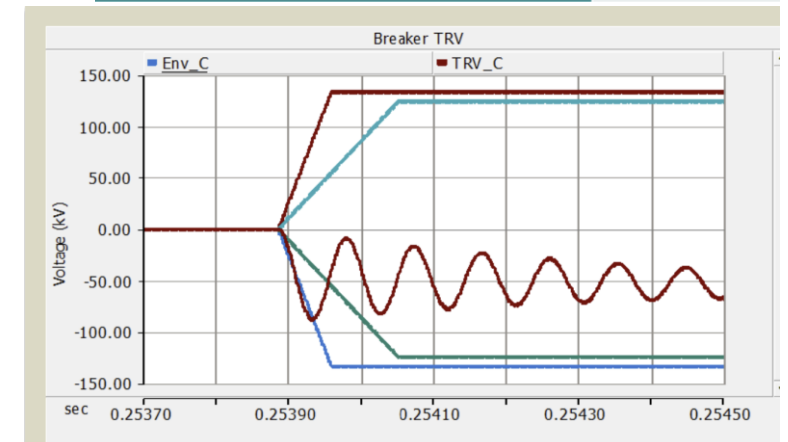
Example Resource: <https://www.pscad.com/knowledge-base/article/286>

Transient Recovery Voltage (TRV) Studies

- Study objective: Simulate how quickly the voltage across a breaker builds up when clearing a fault
- If voltage builds up too quickly, re-strike is possible
- IEEE/IEC standards define withstand voltages
- Modelling considerations:
 - Small time steps, relatively small models required (1 station in-detail + FD T-lines out of station)
 - Stray capacitance
 - Detailed buswork modelling
- Mitigation:
 - Check with breaker manufacturer on actual TRV withstand capability! May be higher than what is in standards
 - If still failing, higher-rated breaker may be needed, or additional devices (e.g. surge/grading capacitor)
- Example Resource: <https://www.pscad.com/knowledge-base/article/683>



Description	Capacitance (pF)
• Earthing Switch	50
• Current Transformer	200
• Capacitive Voltage transformer – outdoor	5500
• Surge Arrester	80
• SF6 to Air Bushing	100
• Voltage Transformer	200



Switching Studies

- Line / transformer energization, faults, capacitor / reactor switching, open-line resonance, and more..
- Study objectives: determine peak overvoltages, peak arrester energies, verify equipment overvoltage ratings not exceeded, check for problematic resonances
- Modelling considerations:
 - Medium-sized model (2-3 buses away may be sufficient) required for the correct frequency response
 - Timestep of few μs to 50 μs (depending on phenomena)
 - Point-on-wave effect for faults/energization
 - Statistical switching
 - Non-linear models important (saturation, remanence, frequency dependant lines etc..)
- Mitigation:
 - Will vary based on specific issue.. Harmonic filters, pre-insertion resistors, point-on-wave breakers,
- Reference: <https://www.pscad.com/knowledge-base/article/684>