



North Carolina A&T
State University

High Research Activity

Marsha Walters, Ph.D.
Assistant Professor
North Carolina Agricultural and Technical State University
School of Technology
Dept. of Electronics, Computers and Information
Technology
Greensboro, NC 27410



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High Research Activity

Technology Curriculum

Undergraduate Power Related Courses

- ❖ ECT355-Electric Power and Machinery
- ❖ ECT360-Industrial Electronics and Controls
- ❖ ECT460-Industrial Measurement and Control
- ❖ ECT455-Power Electronics Applications
- ❖ ECT595-Alternative Energy Systems

Graduate Power Related Courses

- ❖ ECT600-Electromechanical Systems Analysis
- ❖ ECT681-Power Systems Analysis
- ❖ ECT685-Energy and Power



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First Course on Power Systems

Chapter 14

Transient OverVoltages, Surge Suppression, and Insulation Coordination

Friday July 24, 2009



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Chapter 14

- **Causes of Overvoltages**
 - **Lightening Strikes**
 - **Switching Surges**
- **Transmission Line Characteristics and Representation**
- **Insulation to Withstand Voltages**
- **Surge Arrestors and Insulation Coordination**



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Lightening Strike

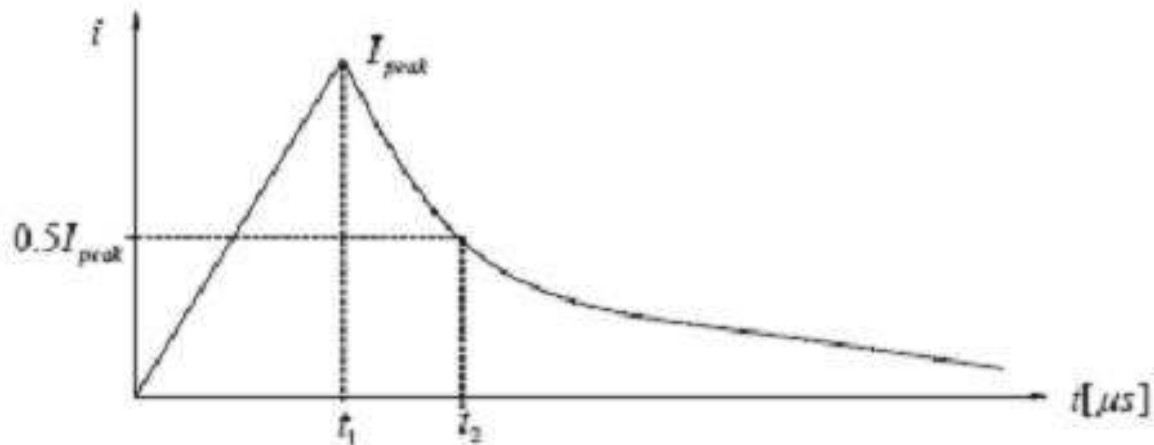


Fig. 14-1 Lightning current impulse.

Lightening strikes to shield wires or conductors result in a brief discharge of a current pulse with respect to ground

- Peak Currents as high as 200 kA
- Overvoltages resulting from 10 to 20 kA are assumed



Lightening Strike to Shield Wire and Backflash

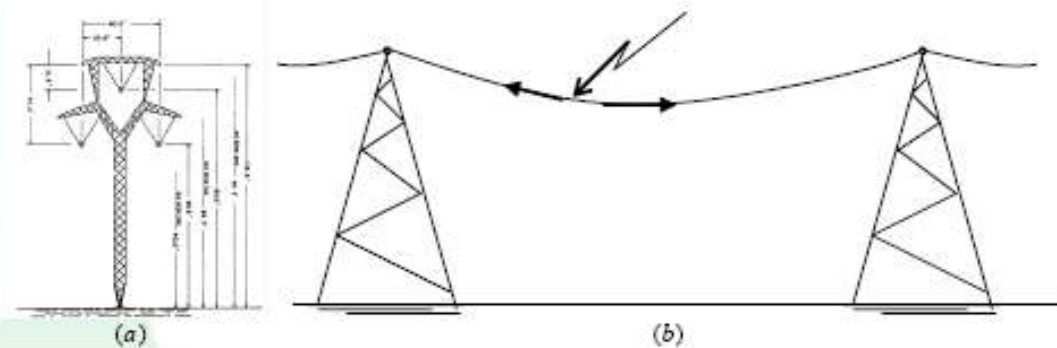


Fig. 14-2 Lightning strike to the shield wire.

- Many transmission lines have shield wires located above the conductors to protect them from lightning strikes.
- When a current pulse due to a lightning strike hits the shield it travels in both directions and passes through the tower to ground as shown.



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Lightening Strikes to Shield Wires or Conductors

- Because of the tower footing resistance and the di/dt of the current pulse, the tower potential may exceed the insulation rating of the insulator string and cause a back-flash resulting in a temporary power outage.
- This may cause a circuit breaker to trip
- Surge arrestors are often used instead of shield wires



Switching Surges

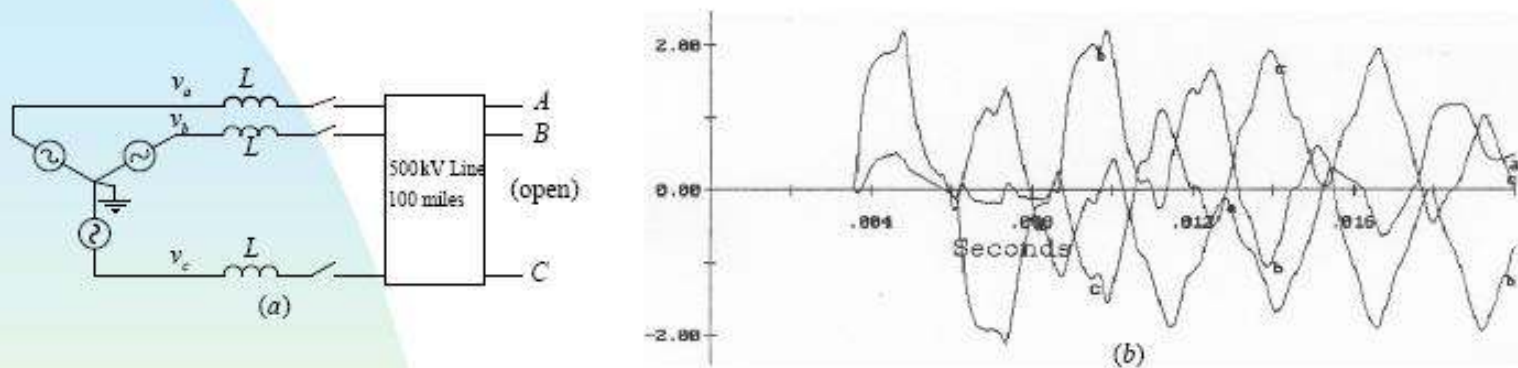


Fig. 14-3 Over-voltages due to switching of transmission lines.

- Surges due to switching can exceed those due to lightning strikes
- These surges can be minimized by adding resistors that are bypassed for normal operation.



Frequency Dependence of Transmission Line Parameters

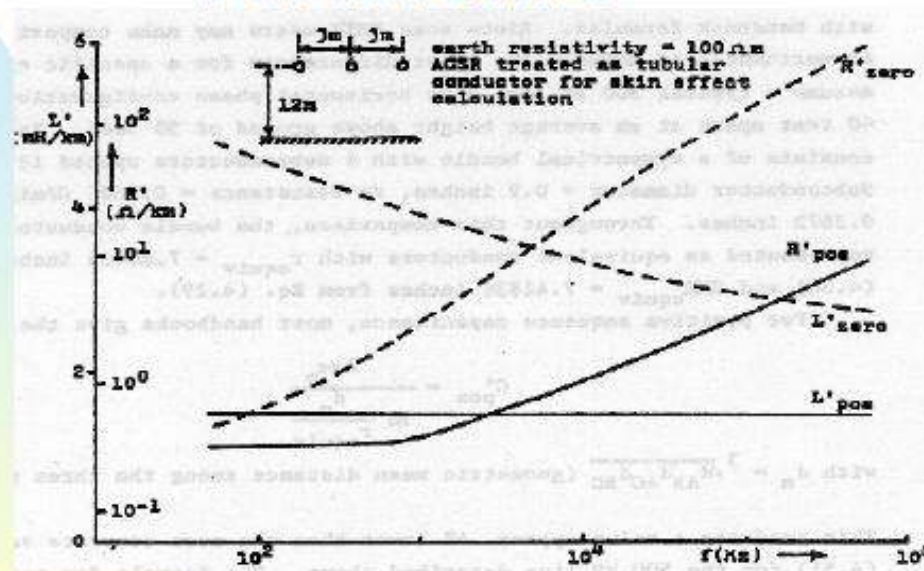


Fig. 14-4 Frequency dependence of the transmission line parameters [Source: 2].



Calculation of Switching Over-Voltages on Line 1-3 in the Example 3-Bus Power System



Fig. 14-5 Calculation of switching over-voltages on a transmission line.

Calculation of switching over-voltages can best be accomplished using software like EMTDC



Standard Voltage Impulse to Define Basic Insulation Level (BIL)

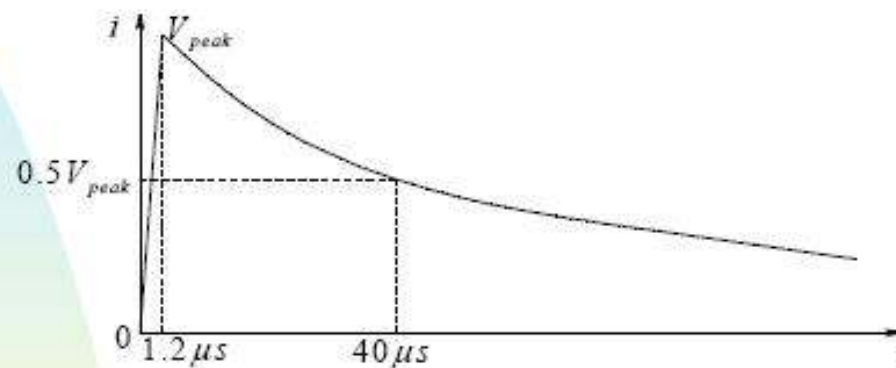


Fig. 14-6 Standard Voltage Impulse Wave to define BIL.