Transmission Line Overvoltage Protection Seminar (4 hrs)

Course Overview

Surge protection of transmission lines is a vital part of the overall reliability of power systems. The degree of surge protection afforded to lines is governed by the reliability required and the economics to obtain such reliability. Lightning outages are among the highest outage rates, the study of transmission line lighting hardening is a recommended venture. The proper selection and application of these devices are the focus of this tutorial.

Course Text and Who Should Attend

The basic text for this course is the presentation slides as shown in the outline below. IEEE 1243 and IEEE C62.22 are the basic resources for this seminar. This tutorial is targeted to those individuals involved in transmission line design, maintenance or specification. Participants will receive .1 CEU for every hour of participation.

The Instructor

Jonathan Woodworth is the Principal Consultant with ArresterWorks. Before starting ArresterWorks in 2008, Jon spent 29 years with Cooper Power Systems holding several arrester associated functions. More than 15 years as Engineering Manager, 7 years as Marketing Manager, and more than 5 years in MOV disk design and production. He is an active participant in both IEC and IEEE arrester standard development.

Course Outline

1.0 Transmission Line Fundamentals as Related to Surge Protection
- 1.1 Types of Lines
- 1.2 Typical System Characteristics

2.0 Surge Fundamentals
- 2.1 Nature of Surges in a Substation
  - 2.1.1 Direct Strike
  - 2.1.2 Nearby Insulator Flashover
  - 2.1.3 Switching Surges
  - 2.1.4 Nearby Strikes
- 2.2 Lightning Currents And Overvoltages
  - 2.2.1 Wave Shapes
  - 2.2.2 Energy Content
- 2.3 Switching Overvoltages

3.0 Arrester Fundamentals
- 3.1 Brief History of Arresters
  - 3.1.1 Pre Silicon Carbide Gapped
  - 3.1.2 Silicon Carbide Gapped
- 3.2 Gapless MOV Arresters
  - 3.2.1 Basic Components of Arresters
  - 3.2.2 Design Considerations
    - 3.2.2.1 VI Characteristics
    - 3.2.2.2 Thermal Characteristics
    - 3.2.2.3 Voltage Withstand Capability
  - 3.2.3 MOV Disk Overview
    - 3.2.3.1 How it works
  - 3.2.4 Design and Industry Trends
- 3.3 Arrester Test Standards
  - 3.3.1 Significant Tests
  - 3.3.2 Insignificant Tests
  - 3.3.3 Acceptance Tests
  - 3.3.4 Changes coming
- 3.4 Types of Arresters Protecting Lines
  - 3.4.1 Station
  - 3.4.2 Intermediate
  - 3.4.3 Distribution
  - 3.4.4 Dual Rated Arresters
  - 3.4.5 Riser Pole Arresters
- 3.5 Arrester Housing Considerations
- 3.6 Grading Rings
  - 3.6.1 Purpose
  - 3.6.2 Installation Considerations
- 3.7 Failure Mode Considerations
  - 3.7.1 Reclosing on a failed arrester
  - 3.7.2 Advantages of Composite Housed Arresters
  - 3.7.3 Hollow Core Design Considerations

4.0 Arrester Selection Procedure
- 4.1 Arrester Selection Summary
- 4.2 Arrester Selection Detail
  - 4.2.1 Select Voltage Rating
  - 4.2.2 Check TOV Capability
    - 4.2.2.1 System TOV Amplitude Considerations
    - 4.2.2.2 System TOV Duration Considerations
    - 4.2.2.3 System TOV Due To Load Rejection
  - 4.2.3 Check Energy Requirements
  - 4.2.4 Switching Surge Durability
  - 4.2.5 Select Arrester Class
  - 4.2.6 Select Available Voltage Ratings
  - 4.2.7 Select Pressure Relief Rating
- 4.3 Determine Protective Characteristics of Selected Arrester
- 4.4 Determine the Insulation Strength of the Protected Equipment

4.5 Evaluate Protective Margins
4.6 Evaluate Maximum Separation Distances
4.7 Evaluation of alternatives

5.0 Line Protection Considerations
5.1 Grounding
5.2 Tower Construction
5.3 Protection of Underground Cables
5.4 Insulator Characteristics
5.5 Arrester Characteristics

6.0 Mechanical Considerations
6.1 Arrester Spacing
6.1.1 Grading Rings influence
6.1.2 Strike Distance
6.1.3 Coordinating Current Used for
6.1.4
6.2 Grounding
6.3 Terminal Connections
6.4 Cantilever Strength
6.4.1 Polymer Housed
6.4.2 Porcelain Housed
6.4.3 Hollow Core Designs
6.5 Mounting Considerations
6.6 Seismic Considerations
6.7 Substation Shielding
6.8 Contamination Considerations

7.0 Field testing
7.1 Safety Considerations
7.2 Partial Discharge Testing
7.3 Thermal Imaging
7.3.1 Standard Methodology
7.3.2 Very Economic Methodology
7.4 Leakage Current Monitoring
7.5 Watts Loss
7.6 Vref
7.7 Sparkover
7.8 Ohmic Testing
7.9 Testing Parallel Column Arresters

8.0 Arrester Disposal
8.1 Hazardous Materials
8.2 Non Hazardous Materials

9.0 Overview of Suppliers
9.1 Review of all major suppliers offering
9.1.1 Business Overview of each Supplier
9.1.2 Basic Design considerations of each Supplier
9.2 Understanding Catalog Sections
9.2.1 What's important and what's not

10.0 Trends in Arrester Industry
10.1 Smart Arresters
10.1.1 Attributes of a Smart Arrester
10.2 Voltage Ratings
10.3 Who's working on what

11.0 Modeling in EMTP and ATP
11.1 Arrester Models
11.2 Testing Models
11.3 Source for Alternate Arrester Data
11.4 Modeling Separation Distance in a Substation

12.0 Compact Line Considerations with Respect to Arresters
12.1 Arresters
12.2 BIL
12.3 Losses
12.4 Power Frequency
12.5 Insulator Considerations

