Distribution System Overvoltage Protection Seminar

This Seminar is intended for Distribution Standard Engineers, Operations Personnel, and Consulting Engineers. The application of Distribution Arresters and Distribution System Protection from the Substation to the Customer will be discussed in detail. This is a 1.5 day course.

1.0 Lightning Fundamentals as Related to Surge Protection
- 1.1 Where is lightning protection needed
- 1.2 Relation of lightning protection and system reliability
- 1.3 Overview of where lighting protection and arresters are used on power systems.

2.0 Surge Fundamentals
- 2.1 Nature of Surges
  - 2.1.1 Lightning Fundamentals
  - 2.1.2 Direct Strike
  - 2.1.3 Insulator Flashover
  - 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
- 2.4 Ferroresonance
- 2.5 Backflash

3.0 Lightning Protection Fundamentals
- 3.1 Shielded Systems
- 3.2 Arrester Protection
- 3.3 Line and Equipment Protection
- 3.4 Underground
- 3.5 Overbuild

4.0 Insulation Coordination
- 4.1 BIL and other Withstand Characteristics
- 4.2 Margin of Protection

5.0 Arrester Fundamentals
- 5.1 Brief History of Arresters
  - 5.1.1 Pre Silicon Carbide Gapped
  - 5.1.2 Silicon Carbide Gapped
- 5.2 Gapless MOV Arresters
  - 5.2.1 Basic Components of Arresters
- 5.3 Design Considerations
  - 5.3.1 VI Characteristics
  - 5.3.2 Thermal Characteristics
  - 5.3.3 Voltage Withstand Capability
- 5.4 MOV Disk Overview
  - 5.4.1 How it works
- 5.5 Design and Industry Trends

6.0 Types of Arresters
- 6.1.1 Station
- 6.1.2 Intermediate
- 6.1.3 Distribution
- 6.1.4 Dual Rated Arresters
- 6.1.5 Riser Pole Arresters
- 6.1.6 Elbow
- 6.1.7 Oil Immersed
- 6.1.8 Externally Gapped
- 6.2 Arrester Housing Considerations
  - 6.2.1 Porcelain
  - 6.2.2 Polymer
- 6.3 Grading Rings
  - 6.3.1 Purpose
  - 6.3.2 Installation Considerations

7.0 Arrester Selection Procedure
- 7.1 Arrester Selection Summary
- 7.2 Arrester Selection Detail
  - 7.2.1 Select Voltage Rating
  - 7.2.2 Check TOV Capability
    - 7.2.2.1 System TOV Amplitude
    - 7.2.2.2 System TOV Duration
    - 7.2.2.3 System TOV Due To Load Rejection
  - 7.2.3 Check Energy Requirements
  - 7.2.4 Switching Surge Durability
  - 7.2.5 Select Arrester Class
  - 7.2.6 Select Available Voltage Ratings
  - 7.2.7 Select Pressure Relief Rating
- 7.3 Determine Protective Characteristics of Selected Arrester
- 7.4 Determine the Insulation Strength of the Protected Equipment
- 7.5 Evaluate Protective Margins
- 7.6 Evaluate Maximum Separation Distances and Lead length
- 7.7 Evaluation of alternatives

8.0 Protected Equipment Considerations
- 8.1 Protection of Transformers
  - 8.1.1 What we know about aging insulation
  - 8.1.2 What is a reasonable Protective Margin
  - 8.1.3 Separation Distance Revisited
- 8.2 Protection of Distribution Lines
- 8.3 Protection of Transmission Lines
  - 8.3.1 Backflash
- 8.4 Protection of Shunt Capacitor Banks
  - 8.4.1 How to effectively Parallel Arresters
- 8.5 Protection of Underground Cables
  - 8.5.1 Sheath Voltage Limiters
- 8.6 Protection of Gas-insulated Substations (GIS)
- 8.7 Protection of FACTS Equipment
  - 8.7.1 Fixed Series Compensation
    - 8.7.1.1 How to Determine MOV Characteristics
  - 8.7.2 Static Var Compensators
- 8.8 Protection of Circuit Breakers - TRV Control
- 8.9 Protection of CT and CCVT

9.0 Mechanical Considerations
- 9.1 Arrester Spacing
  - 9.1.1 Grading Rings influence
  - 9.1.2 Strike Distance
  - 9.1.3 Coordinating Current Used for
  - 9.1.4
- 9.2 Grounding
- 9.3 Terminal Connections
- 9.4 Cantilever Strength
  - 9.4.1 Polymer Housed
  - 9.4.2 Porcelain Housed
  - 9.4.3 Hollow Core Designs
- 9.5 Mounting Considerations
- 9.6 Seismic Considerations
- 9.7 Substation Shielding
- 9.8 Contamination Considerations

10.0 Arrester Test Standards
- 10.1 Significant Tests
- 10.2 Insignificant Tests
- 10.3 Acceptance Tests
- 10.4 Changes coming

11.0 Field testing
- 11.1 Safety Considerations
- 11.2 Partial Discharge Testing
- 11.3 Thermal Imaging
  - 11.3.1 Standard Methodology
  - 11.3.2 Very Economic Methodology
- 11.4 Leakage Current Monitoring
- 11.5 Watts Loss
- 11.6 Vref
- 11.7 Sparkover
- 11.8 Ohmic Testing
- 11.9 Testing Parallel Column Arresters

12.0 Failure Mode Considerations
- 12.1 Reclosing on a failed arrester
- 12.2 Advantages of Composite Housed Arresters
- 12.3 Hollow Core Design Considerations

13.0 Arrester Disposal
- 13.1 Hazardous Materials
- 13.2 Non Hazardous Materials

14.0 Overview of Suppliers
- 14.1 Review of all major suppliers offering
  - 14.1.1 Business Overview of each Supplier
  - 14.1.2 Basic Design considerations of each Supplier
- 14.2 Understanding Catalog Sections
  - 14.2.1 What's important and what's not

15.0 Trends in Arrester Industry
- 15.1 Smart Arresters
  - 15.1.1 Attributes of a Smart Arrester
- 15.2 Housing Materials
- 15.3 Who's working on what

16.0 Modeling in EMTP and ATP
- 16.1 Arrester Models
- 16.2 Testing Models
- 16.3 Source for Alternate Arrester Data

