Substation: From the Outside Looking In.
Moderator

Ron Spataro
AVO Training Institute Marketing Manager
Send us your questions and comments during the presentation.
Today’s Presenter

- Greg Richmond
  AVO Training Specialist
A Second Look at a Substation Components and their Functions

- Small review of the first Substation webinar
- Substation layout
- Conductors
- Various types of Switches
- Surge Arrestors
- Battery Maintenance
- Capacitor Banks
- Transitions
- Terminations
- Importance of One-line diagrams
- Down and Dirty with testing
- Safety (of course)
Review of first webinar

- Types of power generating systems
  - Nuclear, Fossil, Hydro, Wind, and Solar
- Step and Touch Potential within a Substation
- Substation grounding grid
  - IEEE Std 80-2000 – Conductors and Connections
  - IEEE Std 837-1989 – Application and Testing
- Substation Types
  - Transmission, Sub-transmission, Distribution, and Residential
Review of first webinar

- Transformers
  - Step-up and Step-down
- Circuit Breakers
  - Air, Oil, Vacuum, SF6
- Instrument Transformers
  - Types and purpose
- Switchgear
- Safety within the Substation
Typical Substation Layout

- Single Bus System
- Single Section Bus System
- Double Bus System
- Double Breaker Bus System
- One and Half Bus System
- Transfer Bus System
- Ring Bus System
Single Bus System

- Most simple and cheapest design.
- All feeders and transformer bay are connected to one bus.
Single Section Bus System

- A little more advanced than a single bus due to the sectionalizing circuit breaker involved.
- Isolation and back feed is an advantage with this section.
Double Bus System

- Two identical bus bars are used in such a way that any outgoing or incoming feeder can be taken from any of the bus.
- Every feeder is connected to both of the buses in parallel through individual isolator.
Double Breaker Bus System

- Similar to double bus bar system.
- Two identical bus bars are used in such a way that any outgoing or incoming feeder can be taken from any of the bus.
One and a Half Bus System

- An improvement on the double breaker scheme to effect saving in the number of circuit breakers.
- For every two circuits only one spare breaker is provided.
Transfer Bus System

- Alternative of double bus system.
- With this bus, every feeder line is directly connected through an isolator to a second bus called transfer bus.
This system provides a double feed to each feeder circuit, opening one breaker under maintenance or otherwise does not affect supply to any feeder.
Conductors

- Simple: to carry electrical energy form one place to other.
- The choice of conductor depends on the cost and efficiency.
- Solid
- Stranded
- Copper
- Aluminum
Electrical Insulator must be used in electrical system to prevent unwanted flow of current to the earth from its supporting points.

3 Types
- Porcelain
- Glass
- Polymer
Insulators in use

- Pin Insulators
  - Usually used in power network up to 33 KV system.
  - Can be one part, two parts or three parts type, depending upon application voltage.
  - For 33KV two parts and for 66KV three parts pin insulator are generally used.
Suspension Insulators

- For higher voltage, beyond 33KV, it becomes wasteful to use pin insulator because size, weight of the insulator become heavier.
Insulators in use

- Strain Insulators
  - When there is a dead end or there is a sharp corner in transmission line, the line has to sustain a great tensile load of conductor or strain.
## Insulators Ratings

<table>
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<th>Rated System Voltage</th>
<th>Number of disc insulator used in strain type tension insulator string</th>
<th>Number of disc insulator used in suspension insulator string</th>
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<tr>
<td>33KV</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>66KV</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>132KV</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>220KV</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>
Various Switchers

- Gang operated
- Open air
- Interrupter type
  - Vacuum
  - SF6
Surge Arrestors

- Used to protect against over voltage transients caused by external or internal events
Battery Maintenance

- Used in a control house to provide backup power for controls in case of a blackout
Capacitor Banks

- Used to control the level of the voltage supplied to the customer by reducing or eliminating the voltage drop in the system caused by inductive reactive loads.
Terminations

- **Pothead**
  - Separates the “bunched up conductors”
  - Provides weather protection

- **Dead Front**
  - All connections are totally shielded.
  - Provides a higher level of protection from moisture and contamination

- **Live front**
  - Exposed live connections
  - Provides adequate weather protection based on class and material
Transitional structures

- Overhead
  - Concrete
  - Wooden
  - Steele

- Underground
  - Risers
  - Junction boxes
Towers
Importance of One-Line Diagrams

- Display the configuration of the components within the substation.
- Shows normal and abnormal conditions.
- Allow the technician to properly troubleshoot the system.
- Indicates which components needed to isolate and ground.
- Technicians need to be able to read and understand the diagram.
- Need to be Up-to-date!
Down and dirty with testing

- Testing all apparatus in the substation.
  - Manufactures Specifications
  - State and local standards
  - NETA
  - AVO offers training to test substation equipment.
Substation Safety

- Isolate and earth ground.
- Proper work permits and Authorization.
- Proper signage at the site.
- Authorized personnel only.
- Necessary testing of equipment.
- EH rated rubber soled shoes.
- Watches rings and shiny things.
- Tool and equipment accountability.
- Complacency!
Summary

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Hands-On Substation Training

- Substation Maintenance I: 4.5 Days – 3.6 CEUs
- Substation Maintenance II: 4.5 Days – 3.6 CEUs
- Power Factor Testing: 3 Days – 2.4 CEUs
- Transformer Maintenance & Testing: 4.5 Days – 3.6 CEUs
- Advanced Transformer Maintenance & Testing: 4.5 Days – 3.6 CEUs
- Battery Maintenance & Testing: 4 Days – 3.2 CEUs
Save the Date for Our Next Webinar

Tuesday April 17, 2018 at 1pm – 2pm CDT

Title: "A Technicians Approach to Phase and Ground Directional Overcurrent Relaying"

Presented by: Dennis Moon
AVO Training Institute, AVO Senior Training Specialist
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