Distribution Phasing at Line Devices
PSE Overview

- PSE serves over 1,000,000 electric customers across 8 counties in Western Washington
- 300 distribution substations
- 1500 distribution circuits
- 100 distribution automation circuits
  - 75 new automation circuits planned in 2019
- 775 active reclosers
  - 200 new reclosers planned in 2019
Objectives

- Challenges for distribution phasing
- Need for good construction standards
- Phasing for directionality
- Available tools for troubleshooting
  - Software
  - Hardware
- Walk through of field troubleshooting scenario
- Phasing equipment overview
- Field demo??
Distribution Phasing Standard
Recloser Construction Standard

NOTE: Make source and load side connections as shown. The source should be connected to the vertical bus bar of the recloser. The recloser is bidirectional and the connections may be made opposite of shown if absolutely necessary due to framing restrictions, following how the recloser can be mounted/installed. Always connect triplex service to the electrical "source" circuit.

Connect recloser ground (threaded insert and frame) to system neutral or pole ground.

NOTE: Do not cover the pole tag.

NOTE: Secure recloser controller with PSE parklock 4" to 6" Above grade.

NOTE: If recloser is part of a distribution automation scheme, install additional "DIST AUTO" pole labeling. If recloser is at a non-sectional, add "NO" label.

PSW SOUND ENERGY
Vacuum High Voltage Schematic
Adjustment Settings

**Current And Voltage Connection Settings**

**Warning:** EZ settings may override some of these settings

3PVOLT  True three-phase voltage connected
- **N** ▼  Select: N, Y

PHANTV  Phantom voltages from
- **OFF** ▼  Select: OFF, VA, VB, VC, VAB, VBC, VCA

VPCONN  V123 Terminal Conn.
- **A** ▼  Select: OFF, A, B, C, AB, BC, CA

IPCONE  I123 Terminal Conn.
- **ABC** ▼  Select: ABC, ACB, BAC, BCA, CAB, CBA

CTPOL  CT Polarity
- **POS** ▼  Select: POS, NEG
Expected Installation

Oil Filled "Positive CT Polarity"
As Found Phasors

\[ \begin{align*}
IA &= 99.85 \, A \quad \angle 60.17^\circ \\
IB &= 100.44 \, A \quad \angle 179.86^\circ \\
IC &= 99.32 \, A \quad \angle -60.15^\circ \\
VA &= 7.20 \, kV \quad \angle 0.00^\circ \\
VB &= 7.20 \, kV \quad \angle -120.00^\circ \\
VC &= 7.20 \, kV \quad \angle 120.00^\circ \\
I1 &= 0.14 \, A \quad \angle -32.38^\circ \\
3I2 &= 299.61 \, A \quad \angle 59.96^\circ \\
30^\circ &= 1.52 \, A \quad \angle 151.61^\circ \\
V1 &= 7.20 \, kV \quad \angle 0.00^\circ \\
3V2 &= 0.00 \, kV \quad \angle -120.00^\circ \\
3V0 &= 0.00 \, kV \quad \angle 180.00^\circ 
\end{align*} \]
Troubleshooting Steps

1. Confirm source and load connections.
Troubleshooting Steps

1. Confirm source and load connections.

2. Check for correct CT polarity and adjust in settings if necessary.
Recloser Installed Backwards
Troubleshooting Steps

1. Confirm source and load connections.

2. Check for correct CT polarity and adjust in settings if necessary.

3. Determine primary phasing and adjust in settings if necessary.
Troubleshooting Steps

1. Confirm source and load connections.

2. Check for correct CT polarity and adjust in settings if necessary.

3. Determine primary phasing and adjust in settings if necessary.

4. Determine station service phasing and adjust in settings if necessary.
Actual Installation

Oil Filled "Negative CT Polarity"
Expected vs Actual

Source

Load

Source

Load

Oil Filled "Positive CT Polarity"

Oil Filled "Negative CT Polarity"
Expected vs Actual

Before Adjustments

After Adjustments
Phase Identification
Phase Trakker

- AP30 Reference Unit
- AP30 Field Unit
- Hotstick Unit

GPS Timing
Wireless Network

2:57:40
5 ms

109°

5 ms
16.7 ms
X 360° = 109°

2:57:40
10.6 ms

229°

10.6 ms
16.7 ms
X 360° = 229°

109° - 229° = -120°

Re-ference
Field
Difference

Measured phase is -120° “B”
Phase Trakker

ACB Sequence

Three-Phase Voltage Waveforms

Voltage

V_C lags V_A by 120°
V_B leads V_A by 120°

V_C leads V_A by 240°
V_B lags V_A by 240°

±180° Range

+360° Range

Zero Crossing Rising
Phase Trakker Base Unit
Phase Trakker Base Unit
Phase Trakker Base Unit

GPS Antenna (Bayonet Connector)

Network Antenna (Threaded Connector)

AC Power Cord Connection

AC Power Input Selector Switch

Alarm (switch)
COM - Common
NC - Normally Closed
NO - Normally Open

Alternate AC Power Connection
N - Neutral
GND - Ground
L - Line

PUGET SOUND ENERGY
Phase Trakker Readings

Phase Labels

1st Phase in Sequence

2nd Phase in Sequence

3rd Phase in Sequence

Read Status

Current Reference Unit

Current Phase Shift Value

Read

Records

Setup

Most recent Record saved

Record

31

B : -116°

EDM REFUNIT #1

Shift: 0° Offset: .43°
Sep 20, 2010 11:52:49 AM
40° 16' 40.92"N
105° 21' 35.64"W

Battery status and network connection (lower case when low signal strength)
Phase Trakker Readings

Middle position with 2 beeps for 2nd Phase in sequence

B: -118°

Saved Record for current reading
Phase Trakker Records
Phase Trakker Jr

Any mode selection returns to main screen

1 phase ID per reading
3 phase IDs per reading
1 phase ID per reading on single-phase secondary
Phase Trakker Jr
Challenges for distribution phasing

Need for good construction standards

Phasing for directionality

Available tools for troubleshooting
  - Software
  - Hardware

Walk through of field troubleshooting scenario
Questions ????

Thank You!