Chapter 8
Overvoltage (59) Protection Testing

1. Application

Higher-than-rated voltages stress the electrical insulation of equipment and cause it to deteriorate. The effects of over-voltages are cumulative and may cause in-service failures over time. Over-voltage (59-element) protection is applied to protect the equipment and will operate if the system voltage rises above the 59-element pick-up setting. 59-elements almost always incorporate time delays to prevent nuisance tripping caused by transients or swells in the system voltage.

While the actual 59-Overvoltage protection is relatively simple, it can be difficult to determine the correct voltage application. The voltage element settings are often related to the nominal line voltage setting of the relay. The nominal PT secondary voltage could be line-line or line-ground voltages depending on the system, number of potential transformers (PTs), and/or the PT connection as discussed in the "Instrument Transformer" section of Chapter 1.

After you have determined whether the relay measures phase-to-phase or phase-to-neutral, you should review the relay's 59-element and relay nominal voltage settings and make sure that they are correct. For example; If a relay is connected to a system with two PTs, the nominal voltage is likely to be between 115-120V and would be phase-phase voltages. A 59-element setting below 115V will likely cause nuisance trips.

Sometimes a 59-element will be applied to monitor breaker status or to determine whether a bus or line is energized. These applications will have lower voltage settings (approximately 30V) and are used in control applications.

2. Settings

The most common settings used in 59-elements are explained below:

A) Enable Setting

Many relays allow the user to enable or disable settings. Make sure that the element is ON or the relay may even prevent you from entering settings. If the element is not used, the setting should be disabled or OFF to prevent confusion.

B) Pickup

This setting determines when the relay will start timing. Different relay models use different methods to set the actual pickup. Make sure you determine whether Line-to-Line or Line-to-Neutral voltages are selected in the relay. The most common pickup setting definitions are:

- **Secondary Voltage** – Pickup = Setting
- **Multiple of Nominal or Per Unit (P.U.)** – If the relay has a nominal voltage setting, it could be a multiple of the nominal voltage as defined or it could be a multiple of the nominal PT secondary if a nominal PT secondary setting exists in the relay.
  Pickup = Setting x Nominal Volts, OR
  Pickup = Settings x Nominal PT secondary setting
- **Primary Volts** – There must be a setting for PT ratio if this setting style exists. Check the PT ratio from the drawings and check to make sure that the drawing matches the settings.
  Pickup = Setting / PT Ratio, OR
  Pickup = Setting * PT secondary / PT primary

C) Time Curve Selection

59-element timing can be a fixed time (definite time), or instantaneous like the 50-Elements discussed previously, or can be a curve similar to 51-element timing. This setting determines which characteristic applies. DO NOT assume that the time delay setting with a "Definite" time curve selection is the actual expected element time. Some "Definite Time" settings are actually inverse time curves. Check the manufacturer's literature.

D) Time Delay

The time delay setting for the 59-element can be a fixed time delay that determines how long (in seconds or cycles) the relay will wait to trip after the pickup has been detected.

59-elements can also be inverse time curves and this setting simulates the time dial setting of an electro-mechanical relay. ANSI curves usually have a time delay between 1 and 10 and IEC time delay setting are typically between 0 and 1.

E) Reset

Electro-mechanical 59-element relay timing was controlled by a mechanical disc that would rotate if the voltage was higher than the pickup setting. If the voltage dropped below the pickup value, the disc would rotate back to the reset position. The disc would move to the reset position faster in relation to a smaller voltage input.

Some digital relays simulate the reset delay using a linear curve that is directly proportional to the voltage in order to closely match the electro-mechanical relay reset times. Other relays have a preset time delay or user defined reset delay that should be set to a time after any related electro-mechanical discs.

Some relays will reset immediately after the voltage drops below the pickup voltage.